DENISON UNIVERSITY BULLETIN

Volume XXXIX, No. 7

JOURNAL

OF THE

SCIENTIFIC LABORATORIES

Volume XXXIV **Articles 4-5** **Pages 65 to 169**

EDITED BY

W. C. EBAUGH

Permanent Secretary Denison Scientific Association

4. New Ostracodes from the Menard Formation. By Carey Croneis and Hubert M. Bristol 65
5. Pioneering in Yeneseiland. A Transect across Siberia from Mongolia to the Arctic. By George B. Cressey 103

GRANVILLE, OHIO

AUGUST, 1939

The University Bulletin is issued bi-monthly and is entered at the Post Office in Granville, Ohio, as mail matter of the Second Class

JOURNAL OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY

The entire file of volumes 1 to 13 was destroyed by fire; no publications issued prior to 1907 are now available. Volumes 14 to date may be obtained from the editor at $2.00 per volume, with the exception of volume 15, the price of which is $1.00. Separate parts, as listed below, may be purchased at the prices indicated.

VOLUME 14

Articles 1–5, pp. 1–60; Nov., 1908 ..... $0.50
- Pre-Wisconsin drift in the Finger Lake Region of New York; F. Carney. 16 pp., 4 figs.
- An esker group south of Dayton, Ohio; Earl R. Scheffel. 15 pp., 6 figs.
- Wave-cut terraces in Keuka Valley, older than the recession stage of Wisconsin ice; F. Carney. 12 pp., 3 figs.
- A form of outwash drift; F. Carney. 8 pp., 1 fig.
- State geological surveys and practical geography; F. Carney. 6 pp.

Articles 6–10, pp. 61–188; April, 1909 ..... $1.00
- Fossils from the Silurian formations of Tennessee, Indiana, and Kentucky; Aug. F. Foerste. 56 pp., 4 plates.
- Studies on Babbitt and other alloys; 10 pp. J. A. Baker.
- A stratigraphical study of Mary Ann Township, Licking County, O. 28 pp., 15 figs. F. Carney.
- Significance of drainage changes near Granville, Ohio; Earl R. Scheffel. 17 pp., 2 figs.
- Age of the Licking Narrows; K. F. Mather. 13 pp., 5 figs.

Articles 11–16, pp. 189–287; June, 1909 ..... $0.75
- A spectrometer for electromagnetic radiation; A. D. Cole. 10 pp., 6 figs.
- The development of the idea of glacial erosion in America; F. Carney. 10 pp.
- Preliminary notes on Cincinnatian fossils; Aug. F. Foerste. 20 pp., 1 plate.
- Notes on Spondylomorum Quaternarium Ehrenb; M. E. Stickney. 5 pp., 1 plate.
- The reaction to tactile stimuli and the development of the swimming movement in embryos of Diemyctylus torsus Eschscholtz; G. E. Coghill. 21 pp., 6 figs.
- The raised beaches of the Berea, Cleveland, and Euclid sheets, Ohio; F. Carney. 25 pp., 5 figs.

Articles 17–18, pp. 289–442; November, 1909 ..... $1.00
- Preliminary notes on Cincinnatian and Lexington fossils; Aug. F. Foerste. 45 pp., 5 plates.
- The pheistocene geology of the Moravia Quadrangle, New York; Frank Carney. 105 pp., 27 figs.

VOLUME 15

Article 1, pp. 1–100; March, 1910 ..... $1.00
- Bulletin in commemoration of Clarence Luther Herrick.

VOLUME 16

Articles 1–3, pp. 1–120; June, 1910 ..... $1.00
- The metamorphism of glacial deposits; F. Carney. 14 pp., 7 figs.
- Preliminary notes on Cincinnatian and Lexington fossils of Ohio, Indiana, Kentucky, and Tennessee; Aug. F. Foerste. 81 pp., 5 figs., 7 plates.
- The abandoned shorelines of the Oberlin Quadrangle, Ohio; Frank Carney. 16 pp., 5 figs.

Articles 4–7, pp. 119–232; Dec., 1910 ..... $0.75
- Standardization of well water in the vicinity of Granville, Ohio; Lily Bell Sefton. 5 pp.
- Chapters on the geography of Ohio; F. Carney.
  - Transportation; 11 pp.
  - Economic mineral products; 47 pp.
  - Glaciation in Ohio; 48 pp.

Articles 8–12, pp. 233–346; April, 1911 ..... $0.75
- The abandoned shorelines of the Vermilion Quadrangle, Ohio; F. Carney. 12 pp., 2 figs.
- Thermo-electric couples; A. W. Davison. 21 pp., 16 figs.
- The Mercer limestone and its associated rocks in the Newark-Zanesville region; Clara G. Mark. 47 pp., 2 plates, 5 figs.
- A study of the supposed hybrid of the Black and Shingle-oaks; Earl H. Foote. 18 pp., 4 plates.
- A case of pre-glacial stream diversion near St. Louisville, Ohio; Howard Clark. 8 pp., 4 figs.

Articles 13–17, pp. 347–423; July, 1911 ..... $0.75
- The Swasey Observatory, Denison University; Herbert C. Wilson. 5 pp., 4 figs.
- The contribution of Astronomy to general culture; Edwin B. Frost. 12 pp.
- The geological development of Ohio; F. Carney. 15 pp.
- The relief features of Ohio; F. Carney. 13 pp., 1 fig.
- Geographic conditions in the early history of the Ohio country; F. Carney. 20 pp.

VOLUME 17

Articles 1–4, pp. 1–201; March, 1912 ..... $1.50
- A geographic interpretation of Cincinnati, Ohio; Edith M. Southall. 16 pp.
- Strophomena and other fossils from Cincinnatian and Mohawkian horizons, chiefly in Ohio, Indiana, Kentucky; Aug. F. Foerste. 158 pp., 18 plates.
- Population centers and density of population; F. Carney. 15 pp.
- The climate of Ohio; F. Carney. 9 pp.

Articles 5–7, pp. 203–246; March, 1913 ..... $0.50
- The twenty-fifth anniversary of the founding of the Denison Scientific Association. 2 pp.
- The foundation of culture; C. Judson Herrick. 14 pp.
- Drainage changes in the Moots Run area, Licking County, Ohio; Harmon A. Nixon and Dexter J. Tight. 11 pp., 1 fig.
- Some pre-glacial lake shorelines of the Bellevue Quadrangle, Ohio; F. Carney. 16 pp., 3 figs.

Articles 8–10, pp. 247–373; March, 1914 ..... $1.00
- Lorraine faunas of New York and Quebec; Aug. F. Foerste. 93 pp., 5 plates.
- A comparative study of circular and rectangular Imhoff tanks; Theodore Sedgwick Johnson. 26 pp.
- Geographic factors in the establishing of the Ohio-Michigan boundary line; Constance Grace Eirich. 7 pp.

Articles 11–14, pp. 375–487; September, 1914 ..... $1.00
- A method of subdividing the interior of a simply closed rectifiable curve with an application to Cauchy's theorem. F. B. Wiley and G. A. Bliss. 14 pp., 3 figs.
- The influence of glaciation on agriculture in Ohio; Edgar W. Owen. 4 pp., 1 fig.
- The Locust Grove Esker, Ohio; James D. Thompson, Jr. 4 pp., 1 fig.
- Notes on Agelacrinidae and Lepadocystinae, with descriptions of Thresherodiscus and Brockocystis; Aug. F. Foerste. 88 pp., 6 plates.

VOLUME 18

Articles 1–3, pp. 1–284; December, 1915 ..... $1.75
- Proceedings of the inauguration of President Chamberlain. 54 pp.
- Denison University presidents; William Hannibal Johnson. 5 pp.
- The fauna of the Morrow Group of Arkansas and Oklahoma; Kirtley F. Mather. 226 pp., 2 figs., 16 plates.

Articles 4–7, pp. 285–378; December, 1916 ..... $1.00
- Notes on Cincinnatian fossil types; Aug. F. Foerste. 71 pp., 7 plates.
- The shorelines of glacial lakes Lundy, Wayne, and Arkona, of the Oberlin Quadrangle, Ohio; Frank Carney. 6 pp., 1 fig.
- The progress of Geology during the period 1891–1915; Frank Carney. 8 pp., 4 figs.
- The abandoned shorelines of the Ashtabula Quadrangle, Ohio; Frank Carney. 24 pp., 4 figs.

VOLUME 19

Articles 1–4, pp. 1–64; April, 1919 ..... $0.75
- Echinodermata of the Brassfield (Silurian) formation of Ohio; Aug. F. Foerste. 30 pp., 7 plates.
- America's advance in potash production; W. C. Ebaugh. 14 pp., 2 figs.
- The use of outline charts in teaching vertebrate paleontology; Maurice G. Mehl. 8 pp., 1 fig., 4 plates.
- Some factors in the geographic distribution of petroleum; Maurice G. Mehl. 9 pp., 2 plates.

Articles 5–8, pp. 65–146; September, 1919 ..... $0.75
- Notes on Isotelus, Achrolichas, Calymene and Encrinurus; Aug. F. Foerste. 18 pp., 6 plates.

NEW OSTRACODES FROM THE MENARD FORMATION[1]

CAREY CRONEIS AND HUBERT M. BRISTOL

Received March 25, 1939; published September 9, 1939

INTRODUCTION

The micropaleontologic study of the Illinois Chester sediments (late Mississippian) was undertaken by the senior author a number of years ago at the suggestion of Dr. M. M. Leighton. Although this general investigation is far from completed, recent drilling activity in the Illinois Oil Basin has made it imperative that at least progress reports be published, especially on the studies of fossil ostracodes, since this group may well have utilitarian value in oil field correlation.

This paper on Menard species, and the four other articles on the Chester ostracodes published in this JOURNAL serve merely to indicate some of the new species and genera to be expected in well cuttings and surface outcrops of the five formations discussed. No attempt is made here to describe the complete ostracode fauna, nor is it practical at this time to give the complete geological ranges for the species which are described. These pages are intended only to provide the bases for future specific comparisons, and further research. For this reason some of the references to families and genera, as well as some of the orientations, are to be regarded as provisional.

ACKNOWLEDGMENTS

The material yielding the ostracodes described in this paper was obtained from the outcrops of the Menard formation in southern Illinois. Most of the collecting was done by L. E. Workman and

[1] Published with the permission of Dr. M. M. Leighton, Chief, Illinois Geological Survey. See Croneis and Gale (1938) for more detailed sections concerning Introduction, Acknowledgments, and Laboratory Procedure.

J. E. Lamar of the Illinois Geological Survey, or by members of that organization under their direct supervision. Some of the ostracodes were sorted out in a preliminary way by J. E. Lamar before the samples were sent to Walker Museum. To both of these men and their staffs, and especially to Dr. M. M. Leighton, chief of the Illinois Geological Survey, we are pleased to acknowledge our indebtedness. We are also under obligation to a long list of anonymous graduate students for sample preparations and preliminary sorting. Finally, we are indebted to W. Schmidt and Michael S. Chappars for photographic assistance.

THE MENARD FORMATION

The Menard formation occurs just below the middle of the Upper Chester Series, as is shown by the accompanying table of Illinois Chester Formations:

Upper Chester	Kinkaid limestone and shale
	Degonia sandstone
	Clore limestone and shale
	Palestine sandstone
	MENARD limestone and shale
	Waltersburg sandstone
	Vienna limestone and shale
	Tar Springs sandstone
Middle Chester	Glen Dean limestone and shale
	Hardinsburg sandstone
	Golconda limestone and shale
	Cypress sandstone
Lower Chester	Pain Creek limestone and shale
	Bethel sandstone
	Renault limestone and shale
	Aux Vases sandstone

According to Stuart Weller (1922) the Menard lies apparently disconformably between the underlying Waltersburg sandstone and the overlying Palestine sandstone, although the actual contacts have not been seen. The type section of the formation is in Randolph County, and other typical exposures of this formation occur in the Mississippi River bluffs between Menard and Chester. Outcrops are known in Union, Johnson, Pope, and

Hardin Counties in Illinois; and in Kentucky it crops out in the Golconda, Fordsville and Cannelton Quadrangles.

Lithologically, the Menard formation is variable. Weller, however, considered it the most persistent unit in the entire Chester Series. Petroleum geologists generally concur in this opinion. The formation consists chiefly of limestone, but a considerable amount of shale is present, and there are unimportant sporadic layers of coal, sand and chert. The limestone varies from shaly, carbonaceous members through dense, hard limestone layers, to divisions which are crystalline. The Menard, in contrast to the Glen Dean and the Golconda formations, is more dense and resistant. In color the limestone members vary from nearly black to buff, including shades of blue and grey. The shale beds, which locally are very prominent, are argillaceous to calcareous. The thickness of the Menard probably nowhere exceeds 175 feet, and its average thickness is probably less than 100 feet. The maximum measurement thus far reported was made in Pope County, Illinois, where the Menard is 165 feet thick. In Kentucky the formation is less than 10 feet thick at many outcrops.

The limestone beds of the Menard formation are fossiliferous, but the rock is commonly so dense that megascopic fossils are hard to collect. The ostracodes described in this paper were collected from the calcareous shales of the formation.

MENARD OSTRACODES

In the last few years several articles on late Mississippian ostracodes have described species from the Renault, Golconda, Clore, Kinkaid, Salem, Amsden, and Reynolds formations. The Reynolds formation of West Virginia appears, on the basis of its described ostracodes, to be of late Chester age. There are, however, notable faunal differences between the Reynolds and Menard formations. These may be due to geographic location rather than to any long time interval separating their deposition.

In any preliminary comparison of the Menard fauna with those of the Renault, Golconda, Clore, and Kinkaid formations, a number of differences are noted. The Renault fauna is markedly

different and older with more primitive glyptopleurids and none of the species of *Carboprimitia*, or *Bairdiolites* which are so common in the Menard and younger formations. The Golconda fauna, in some respects, is surprisingly similar to that of the Menard, but species of *Carboprimitia* are also rare or wanting in the Golconda, and its glyptopleurids are more simple. The Clore and Kinkaid faunas, with *Carboprimitia*, advanced glyptopleurids, *Bairdiolites*, *Cavallina* and *Sansabella*, are very similar. A preliminary examination of the Vienna ostracodes seems to indicate another even more closely related fauna.

The Menard specimens here figured and described, in addition to a number of undescribed species, are deposited in Walker Museum, University of Chicago.

LABORATORY PROCEDURE

A synopsis of the method of preparing the samples and sorting the sediments, together with a brief statement of the photographic procedure, will be found in Croneis and Gale (1938).

LOCALITY NUMBERS

A list of Chester outcrops from which samples have been collected is on file at the Illinois Geological Survey at Urbana. The Menard locality numbers cited in this paper may be found in that register.

SYSTEMATIC DESCRIPTIONS

Class CRUSTACEA

Superorder OSTRACODA Latreille

Family Leperditellidae Ulrich and Bassler

Genus Paraparchites Ulrich and Bassler

Paraparchites inornatus (McCoy)

Cythere inornata McCoy, Syn. Char. Carb. Fossils, Ireland (1844), 167, pl. 23, fig. 18.

Paraparchites inornata Harlton, Jour. of Pal., 1, 203, pl. 32, figs. 1a, b (1927).

Paraparchites inornatus Croneis and Gale, "New Ostracodes

from the Golconda Formation." Den. Univ. Bull., Jour. Sci. Lab. 33, 256, pl. VI, fig. 33, (1938).

Dimensions of a typical specimen: Length, .53 mm.; height, .40 mm.; thickness, .27 mm.

Locality: 022814 No. 7 (C).

Remarks: The specimen is not figured. Several individuals have been found which are doubtfully referred to *P. inornatus.*

Genus Microparaparchites Croneis and Gale

Microparaparchites inornatus Croneis and Bristol, n. sp.

Plate III, figure 31

Carapace subreniform; hinge line straight, prominent posterior swelling rises above hinge line. Hinge line greatly depressed posteriorly. Cardinal angles obtuse, anterior cardinal angle approximately 120°, posterior cardinal angle approximately 100°, posterior outline broadly rounded, swinging into venter with a longer ventral slope than at the anterior end where the outline is more bluntly rounded. Venter convex. Greatest thickness posterio-dorsad of mid-carapace. Area of notable posterior thickness larger and flattened; anterior portion of carapace more uniformly rounded. Surface smooth.

Dimensions of type specimen: Length, .66 mm.; height, .49 mm.; thickness, .33 mm.

Locality: 061972 No. A. Holotype, Walker Museum, No. 45101.

Remarks: This very distinctive species is related to *M. spinosus* of the Golconda formation. It may be distinguished from that form, however, by its lack of a spine and pits on the posterio-dorsal quarter. Moreover the Menard species is relatively somewhat thicker and higher posteriorly.

The genus *Microparaparchites* may have been derived from *Aparchites.*

Microparaparchites spinosus Croneis and Gale

Plate IV, figs. 11, 12

Microparaparchites spinosus Croneis and Gale, "New Ostracodes from the Golconda Formation," Den. Univ. Bull., Jour. Sci. Lab., 33, 256, pl. VI, figs. 30–31, (1938).

Dimensions of a figured specimen: length, .594 mm.; height, .462 mm.; thickness, .21 mm. (single valve).

Locality: P66A 0431.92. Hypotype, Walker Museum, No. 45102.

Remarks: Only one right and one left valve of this species have been found, but both are in an excellent state of preservation. Their nodes are not quite as pronounced as on the type specimen, nevertheless, the Menard individuals are referred to *M. spinosus* with a fair degree of confidence.

The Menard specimens of *M. spinosus* are approximately the same size as those from the Golconda formation. They are, however, somewhat less long in proportion to their height.

Genus Sansabella Roundy

Sansabella johnsoni Croneis and Thurman

Plate III, figs. 5–7

Sansabella laevis Croneis and Thurman, "New Ostracodes from the Kinkaid Formation," Den. Univ. Bull., Jour. of Sci. Lab. 33, 302, pl. VII, figs. 13–14 (1938).

Dimensions of figured specimen: length, .79 mm.; height, .49 mm.; thickness, .42 mm.

Locality: P66A 0431.92. Hypotype, Walker Museum, No. 45103.

Remarks: This figured specimen is referred to *S. johnsoni* (new name for *S. laevis*) of the Kinkaid formation with a considerable degree of certainty. Its measurements are almost identically those of the type.

Family Primitiidae Ulrich and Bassler

Genus Carboprimitia Croneis and Funkhouser

Carboprimitia depressa Croneis and Funkhouser

Plate III, figs. 1–3

Carboprimitia depressa Croneis and Funkhouser, "New Ostracodes from the Clore Formation," Den. Univ. Bull., Jour. Sci. Lab., 33, 337, pl. IX, figs. 1–2 (1938).

Dimensions of figured specimen: length, .86 mm.; height, .59 mm.; thickness, .41 mm.

Locality: P66A 0431.92. Hypotype, Walker Museum, No. 45104.

Remarks: This is perhaps the most common type of ostracode found in the Menard formation. Undoubtedly there are other species or varieties of this genus which may later be described, but they all closely resemble this central type in which individual variation is presumed to be great.

Although the figures and description of the genus *Geffinia* as described by Coryell and Sohn do not check particularly well with our representatives of *Carboprimitia*, it may well be that the ostracodes described under these names are congeneric. If so, *Geffinia* has priority.

Carboprimitia simulans Croneis and Thurman

Plate III, fig. 4

Carboprimitia simulans, Croneis and Thurman, "New Ostracodes from the Kinkaid Formation," Den. Univ. Bull., Jour. Sci. Lab. 33, 303, pl. VII, figs. 23–25 (1938).

Dimensions of figured specimen: length, 1.122 mm.; height, .792 mm.; thickness, .396 mm. (one valve).

Locality: C6 (D). Hypotype, Walker Museum No. 45105.

Remarks: The specimens from the Menard formation seem to be essentially identical with those of the Kinkaid formation except in size, those from the Menard being larger. There is a great amount of individual variation exhibited by species of this genus.

Carboprimitia spinosa Croneis and Bristol n. sp.

Plate III, fig. 8

Carapace subovate in outline, medium sized; hinge line straight or slightly convex, somewhat depressed, and showing conspicuous offsets near the cardinal angles. Posterior cardinal angle approximately 125°; anterior cardinal angle approximately 145°; anterio-ventral and posterio-ventral swings well rounded and

subequal; venter slightly and regularly convex. Surface marked by a prominent sulcus just anterio-dorsad of mid-carapace; sulcus deepened into pit-like depression at its ventral extremity. Central part of right valve flat, falling off precipitously both anteriorly and posteriorly to form a slight flange. Posterio-dorsal angle marked by a small node which is the most diagnostic feature of the species.

Dimensions of type specimen: length, .957 mm.; height, .561 mm.; thickness, .660 mm.

Locality P66A 0431.92. Holotype, Walker Museum, No. 45106.

Remarks: *C. spinosa* is similar to *C. simulans* of the Kinkaid formation, but possesses a node, and its cardinal angles are larger. It also is related to *C. depressa* of the Clore formation, whose surface flattening is very similar.

Genus Perprimitia Croneis and Gale

Perprimitia matheri Croneis and Bristol n. sp.

Plate III, fig. 16

Carapace subrectangular, elongated, small, hinge line slightly concave; cardinal angles obtuse; cardinal angles roughly subequal, anterior angle being more sharply defined; posterior outline more uniformly rounded and less blunt than anterior. Dorso-anterior slope nearly straight. Ventral outline subparallel to hinge line, slightly convex. Right valve somewhat larger than left and overlaps it slightly along free margin; posterior and ventral overlap sub-equal, greater than anterior. Anterior portion of carapace marked by swelling originating just posterior of mid-carapace and below median line in a lobate structure which parallels the shell margin and extends forward and upward to terminate in a low sub-circular node posterioventrad of anterior cardinal angle; posterior region more tumid than anterior; swelling occupies most of posterior area; terminates near posterior cardinal angle in two spines, the smaller of which is somewhat closer to the hinge line, and is directed upward and forward, the larger extending upward and backward; spines

have a common base. Between the two swollen areas lies a shallow curved sulcus with convexity posterior; sulcus extends from hinge line to venter and is expanded just behind the anterior node. Greatest thickness of carapace near center of posterior swelling about at mid-height. Surface smooth.

Dimensions of type specimen: length, .66 mm.; height, .37 mm.; thickness, .37 mm. (one valve).

Locality: 022814 No. 5. Holotype; Walker Museum, No. 45107.

Remarks: *P. matheri* is similar to *P. funkhouseri* of the Kinkaid formation. It may be distinguished from that species by its two dorso-posterior spines. In addition the anterior dorsal slope of *P. matheri* is straight instead of rounded, its posterior swelling is more pronounced, and the surface falls off more precipitously to the posterior margin.

Family Kloedenellidae Ulrich and Bassler

Genus Deloia Croneis and Thurman

Deloia spinosa Croneis and Bristol n. sp.

Plate III, fig. 21

Carapace subovate in outline, medium sized; hinge line straight or slightly convex. Posterior cardinal angle approximately 95°; anterior cardinal angle approximately 135°; posterio-ventral swing much less abrupt than anterio-ventral swing; venter slightly convex. Free margin of valve bordered by a conspicuous, flat rim, tuberculate at outer edge. Surface marked by narrow well defined sulcus slightly anterior of mid-length; sides and base of sulcus form a narrow, vertically elongated "U" which expands broadly near dorsum to make a shallow "Y" shaped depression. Valve surface slopes gradually toward anterior outline with a precipitous drop near the border. A conspicuous node is present on the mid-dorsal portion of the posterio-dorsal swelling.

Dimensions of type specimens: length, .825 mm.; height, .462 mm.; thickness, .16 mm. for one valve.

Locality: C6 (F). Holotype, Walker Museum, No. 45108.

Remarks: This species is similar to *D. sulcata* of the Clore formation. It may be distinguished from the latter by its node and by its more gradual posterio-ventral swing which gives it a more triangular posterior outline. *D. spinosa* also is proportionately longer than either *D. serrata* of the Kinkaid formation or *D. sulcata*. Nevertheless these three species are closely related, and ordinarily are distinguished with some difficulty.

Genus Jonesina Ulrich and Bassler

Jonesina consimilis Croneis and Bristol n. sp.

Plate III, figs. 29–30

Carapace subquadrate to subovate in outline, small; hinge line straight, cardinal angles obtuse, the posterior angle being more obtuse than the anterior which is approximately 110°. Posterior and anterior outlines broadly rounded, the posterior having a much shorter ventral swing; ventral outline broadly convex. Greatest thickness of carapace near mid-carapace, to very slightly anterior to mid length along mid-line. Posteriorly shell surface slopes down to a slightly serrated marginal ridge, which extends from the posterior cardinal angle to venter; anteriorly the surface slopes gradually from the high point to the margin. Shallow sub-triangular sulcus located slightly posterior to mid-length. Valves slightly unequal, left valve larger than right. In dorsal view a slight rim appears above hinge both anteriorly and posteriorly. Surface essentially smooth.

Dimensions of type specimen: length, .64 mm.; height, .37 mm.; thickness, .28 mm.

Locality: P51A 0803.49. Holotype, Walker Museum, No. 45109.

Remarks: *J. consimilis* is closely related to *J. persulcata* of the Golconda formation, being especially similar in lateral view. The Menard species, however, has its area of greatest thickness located very much higher on the shell and it is much less obese than *J. persulcata*. In addition the sulcus of the Menard species is not as strongly defined, and its posterior outline is more uniformly rounded. *J. consimilis* shows some general features in common with *J. vinitaensis* from the Fayetteville

shale, but in that species the shape is different. Moreover, in the latter species the free margins are completely set with spines, and it seems possible that it may belong to the closely related genus *Deloia*.

Jonesina intermedia Croneis and Bristol

Plate III, figs. 10–11

Carapace subovate in outline, medium sized; hinge-line straight or nearly so. Posterior cardinal angle approximately 135°; anterior cardinal angle approximately 120°; anterio-ventral swing more gently rounded and longer than the posterio-ventral slope; posterior outline uniformly rounded. Ventrad convex. A deep narrow sulcus occurs just posterior to mid-length. Behind it lies a well rounded node. Posterior outline marked by a small serrated rim extending from posterior cardinal angle to venter.

Dimensions of type specimen: length, .72 mm.; height, .38 mm.; thickness, .41 mm.

Locality: P51A 0803.49. Holotype, Walker Museum No. 45110.

Remarks: *J. intermedia* is rather similar to *J. spinosa* of the Clore formation, but it lacks the anterior spine of the latter, its cardinal angles are different, and it has a slight posterior rim. *J. intermedia* is probably even more closely related to *J. persulcata* of the Galconda formation. These three difficultly distinguished species probably represent slightly different expressions of the same direct line.

Jonesina lalickeri Croneis and Bristol n. sp.

Plate III, fig. 9

Carapace subovate, small, hinge line straight. Cardinal angles distinct, obtuse, posterior angle the larger; anterior angle about 95°; dorso-anterior outline nearly straight; anterio-ventral swing long and broadly rounded. Venter convex. Slight swelling rises above hinge line just anterior to sulcus. Sulcus shallow and subcentrally located, but slightly posterior to mid-length. Greatest thickness posterio-ventrad of sulcus. Anterior cardinal angle bears a small anteriorly pointed node or spine. Just below

mid-height on posterior margin is located a second node or spine directed posteriorly or slightly ventro-posteriorly.

Dimensions of type specimen: length, .495 mm.; height, .330 mm.; thickness, .26 mm.

Locality: P66A 0431.92. Holotype, Walker Museum, No. 45111.

Remarks: Only left valves of this species have been found. Although each one differs slightly from the others all are thought to be conspecific; and since their features are distinctive the species may be considered well established.

Genus *Denisonia* Croneis and Bristol

Genus characterized by straight hinge line, ridged dorsal outline, frilled border on free margin, and a strong rib dorsad to deep pit.

Remarks: *Denisonia* is vaguely like *Deloia* Croneis and Thurman in outline, and in serrate border, but differs from it in position of pit and in surface markings. In fact it is sufficiently dissimilar to other ostracode genera that even its family position must be regarded for the present as entirely provisional.

Genotype: *Denisonia cincta* Croneis and Bristol n. sp.

Denisonia cincta Croneis and Bristol n. sp.

Plate IV, fig. 13

Second carapace subquadrate to subrhomboidal in outline; medium sized; hinge line straight, dorsal margin consists of a small ridge parallel to hinge line; cardinal angles obtuse, posterior approximately 135°, anterior approximately 110°; anterio-ventral swing longer and less uniformly rounded than posterior. Greatest thickness of carapace ventro-posterior of pit; greatest height just behind pit. A narrow frilled border extends around the free margins. A strong rib extends from posterior frill at mid height diagonally forward and upward, passing dorsad of pit approaches, but does not extend to anterior cardinal angle. Surface smooth.

Dimensions of type specimen: length, .858 mm.; height, .528 mm.; thickness, .31 mm. (single valve).

Locality: M 022814 No. 11 (F). Holotype, Walker Museum, No. 45112.

Remarks: Only three specimens of this distinctive species have been found, nevertheless the preservation is good, and both the species and genus are considered well established.

Genus Neokloedenella Croneis and Funkhouser

Neokloedenella secunda Croneis and Bristol, n. sp.

Plate III, figs. 24, 25

Carapace inflated, subrectangular to subovate in outline; subequivalved; hinge line slightly depressed, straight except for two tongue-like extensions of right valve, one near each cardinal angle. Posterior cardinal angle approximately 160°; anterior cardinal angle approximately 150°; posterior outline more angular than anterior and has a longer swing into venter which is straight or very slightly convex. Posterior tongue narrow, conspicuous, essentially at cardinal angle; anterior tongue larger, broader, subtriangular in outline fits into and over left valve. Greatest thickness near posterior end. Surface smooth or granular; there is some indication of a vague depression anterior to and dorsad of mid-shell.

Dimensions of type specimen: length, .90 mm.; height, .54 mm.; thickness, .40 mm.

Locality: C6 (c). Holotype; Walker Museum, No. 45113.

Remarks: *N. secunda* resembles *N. prima* of the Clore formation rather closely. *N. secunda* may be distinguished, however, by its more angular posterior outline, and by the different configuration of its hinge structure. The species is relatively common in the Menard formation.

Family Hollinidae Swartz

Genus Hollinella Coryell

Hollinella moreyi Croneis and Bristol, n. sp.

Plate IV, fig. 18

Carapace large, subrhomboidal; hinge line straight. Posterior cardinal angle about 120°, posterior ventral swing broadly

and uniformly rounded. Free margin of valve bordered by a wide concave frill which flares upward most conspicuously in posterior quarter; frill apparently terminates anteriorly in a large anterio-ventrally directed spine. Frill radially fluted. Surface marked by two centro-dorsal nodes, separated by a depression; posterior node slightly elongated vertically, and smaller than the anterior one. Surface, except frill, finely and sub-regularly pustulose with a few irregularly placed spinose processes.

Dimensions of type specimen: length, 1.551 mm.; height, .924 mm.; thickness, .72 mm.

Locality: 022814 No. 1 (F). Holotype, Walker Museum, No. 45114.

Remarks: In all specimens in the collection the anterior cardinal corner is missing, so that a definite statement regarding the features of this section of the carapace cannot be made at present. *H. moreyi* differs from *H. typica* of the Amsden formation in that the frill extends to the dorsal hinge line; in addition *H. moreyi* has a larger spine and is less shallow between the nodes. It may be conspecific with the *Hollinella sp.* of the Clore formation.

Family Kirkbyidae Ulrich and Bassler

Genus Kirkbya Jones

Kirkbya fossula Croneis and Bristol n. sp.

Fig. IV, fig. 3

Carapace suboblong, equivalved, medium sized, hinge line long and straight, cardinal angles subequal, approximately 95°. Anterior ventral swing longer and more broadly rounded than posterior ventral swing. Ventral margin very slightly convex to straight in mid portion. Greatest thickness of carapace anterior near mid-height; surface slopes steeply from area of greatest elevation to submarginal ridge. Posteriorly the slope is gentle across central part of carapace but falls just anterior to submarginal carina; surface slope rounded in ventral portion.

Valves carinate, submarginal flange removed from marginal ridge by an area marked by four rows of reticulations; reticulations converge near cardinal angles; flanges narrow and thin, unmarked by reticulations. Surface marked by reticulations which run length of shell. Large kirkbyan pit with an elevated rim occurs just ventrad of mid-height, on slope to ventrad ridge.

Dimensions of type specimen: length, .729 mm.; height, .363 mm.; thickness, .330 mm. one half shell.

Locality: P66A 0431.92. Holotype, Walker Museum, No. 45116.

Remarks: *K. fossula* differs from *K. symmetrica* of the Kinkaid formation in its reticulation pattern and in possessing a large, distinct and prominently rimmed pit. In addition, it has differently arranged marginal ridges whose configuration is also at a variance from that seen in *K. aequalis* of the Clore formation which is an even closer relative. In the latter species, however, the peculiar pit is placed lower on the shell and the area between the marginal ridges is non-reticulate. *K. fossula*, *K. aequalis*, *K. symmetrica*, and *K. marginata* are all closely related species whose separation is difficult without excellent material.

Genus Amphissites Girty

Amphissites concavus Croneis and Bristol, n. sp.

Plate IV, figs. 8, 9

Carapace subequavalved; subquadrate in outline, hinge line straight to slightly concave, cardinal angles obtuse, anterior angle generally slightly more obtuse than posterior angle of approximately 120°. Anterior outline broadly subtriangular, joins venter in an abrupt but well rounded swing; posterior-ventral slope straight, joins venter in a decided angle of approximately 135°. Marginal flange inconspicuous except ventrally where it is thin and high. Posterior shoulder low and short; extends from dorsal hinge line to about mid-height; anterior shoulder higher than posterior but shorter; central node high and round, located slightly behind mid-length and about at mid-height.

Surfaces of both valves adjacent to central node slightly concave inward. Surface finely reticulate, the lines on the lobes tend to follow the general carapace outline.

Dimensions: length, .990 mm.; height, .561 mm.; thickness, .494 mm.

Locality: Sec. 20 S.E. ¼. Holotype; Walker Museum, No. 45118.

Remarks: *A. concavus* is most closely related to *A. trilobus* of the Golconda formation but its surface is more flattened, its nodes are less distinct, and its anterior and posterior outlines are more angular.

Amphissites costellifera Croneis and Bristol, n. sp.

Plate IV, fig. 5

Carapace suboblong, hinge line straight or very slightly concave; venter slightly concave. No sharply distinguishable nodes or lobes, but shell is slightly swollen in mid-carapace and there are prominent marginal and submarginal flanges visible in lateral view; a vague third flange subparallel to the marginal ridge is strongest in the anterior portion; the marginal flange becomes indistinct near the cardinal angles. Posterior outline more blunt than anterior. Reticulations irregular, a few in posterior quarter arranged in weak ridges; "bald" spots are present. · Greatest thickness anterior of mid-length. Cardinal angles subequal, posterior angle slightly less obtuse than anterior. Anterior shoulder rises slightly above hinge line.

Dimensions of type specimen: length, .848 mm.; height, .528 mm.; thickness, .23 mm.

Locality: Sec. 18 RC/M. Holotype, Walker Museum, No. 45117.

Remarks: *A. costellifera* is like *A. ? obesus* of the Golconda formation but it is not as obese and it has a small third flange. *A. costellifera* is also similar to *A. bicarinatus* of the Kinkaid formation but it has no true central node. This Menard species is also a close relative of *A. decipiens* but the latter has a different flange alignment and considerably different surface markings.

Amphissites decipiens Croneis and Bristol, n. sp.

Plate IV, fig. 4

Carapace suboblong, hinge line straight or slightly concave; cardinal angles sub-equally obtuse and rounded. Posterior end somewhat more blunt than anterior. Prominent marginal and submarginal flanges present. Surface reticulate, most irregular and strongest markings in dorso-anterior greater. Elsewhere markings roughly encircle central high point or conform to shell outline. Greatest thickness near mid-carapace from which area the surface slopes off gradually in all directions with a steepness inversely proportional to the distance from the edges. Indistinct pit just ventrad of high point.

Dimensions of type specimen: length, .759 mm.; height, .429 mm.; thickness?.

Locality: Sec. 18 RC/M. Holotype, Walker Museum, No. 45119.

Remarks: *A. decipiens* is much like *A.* ? *obesus* of the Golconda formation but it is not as thick and it lacks a prominent pit. The reticulations are also differently arranged. The Menard species is similar to *A. bicarinatus* of the Kinkaid formation, especially in the arrangement of its flanges, but it lacks the elongate node of the latter form. The associated *A. decipiens* and *A. costellifera* are also closely related species.

Amphissites elongatus Croneis and Bristol, n. sp.

Plate IV, fig. 10

Carapace elongate, suboblong, hinge line straight or slightly concave, depressed; cardinal angles obtuse, rounded, the anterior angle being more obtuse than posterior, anterior outline subuniformly rounded, joins venter in a smooth curve; posterior outline more bluntly rounded, joins venter rather abruptly. Venter straight and elongate and flattened at right angles to surface of shell. Prominent submarginal flange with slight bordering groove, encircles ventral and anterior half of shell. Anterior shoulder more prominent than posterior lobe; anterior

lobe projects above hinge line, is slightly broader than posterior lobe, and dies out ventrally near mid-height; posterior lobe projects slightly above hinge line, dies out ventrally near or a little above mid-height. Both lobes slightly concave toward central node. Prominent, subcentral node lies slightly dorsad of and posterior to mid-point of carapace. Surface finely reticulate, lines of reticulations on the lobes extend down their length and curve inward toward, but below, central node. Shell is swollen on posterio-ventral corner into another vague node-like structure.

Dimensions of type specimen: length, 1.023 mm.; height, .594 mm.; thickness, .231 mm. half valve.

Locality: 022814 No. 11 (E). Holotype; Walker Museum, No. 45120.

Remarks: *A. elongatus* is similar to *A. trilobus* of the Golconda formation but differs from that species in possessing a posterio-ventral swelling, in being proportionately longer, flatter, and less thick. *A. elongatus* is also related to *A. bradfordi* (new name for *A. rothi*) of the Clore formation, but it is longer and less high, its nodes are not as prominent and its submarginal ridge is less well developed.

Despite the distinctive features of many Chester *Amphissites* it has been found that gradational series bridging the gap between most species can readily be assembled. Since this is so, one may well question the validity of many species of the genus, including our own.

Amphissites latinodus Croneis and Bristol, n. sp.

Plate IV, fig. 7

Carapace small, subovate to suboblong, bearing two transverse lobes and a large laterally extended central node; hinge line straight or slightly concave. Posterior cardinal angle approximately 110°. Posterior ridge very low and indistinct; anterior ridge small but distinct; central node located centrally somewhat dorsad of mid-height. A marginal flange extends from cardinal angle to cardinal angle; a prominent submarginal flange

which occurs between marginal flange and central node, is confined to the ventral portion of the shell. Surface subregularly reticulate.

Dimensions of type specimen: length, .46 mm.; height, .29 mm.; thickness, .28 mm.

Locality: P66A 0431.92. Holotype, Walker Museum, No. 45121.

Remarks: The characteristic features of *A. latinodus* are its strong submarginal flange and the longitudinally extended central node.

A. latinodus slightly resembles *A. golcondensis* of the Golconda formation. *A. latinodus* is perhaps more closely related to *A. monomastadis* Coryell and Sohn from the Reynolds formation of West Virginia. In that species, however, the conspicuous ridge on the ventral slope is located higher on the shell and is much longer. The central node of the Menard species is also more elevated, and is located near the hinge line.

Amphissites lineatus Croneis and Bristol, n. sp.

Plate IV, figs. 1, 2

Carapace subrectangular to subovate in outline, medium sized; hinge line depressed, straight or slightly concave. Posterior and anterior cardinal angles subequally obtuse; both anterior and posterior outlines round smoothly and subequally into venter. Prominent submarginal flange and a fine, distinct marginal flange separated by four rows of reticulations. Markings on submarginal flange very distinct "checker" board with dark lines and light areas. Anterior lobe more prominent than posterior lobe; posterior lobe narrower and steeper sided than anterior; anterior node rises above dorsal outline, and extends below mid-height. Posterior lobe high and steep sided, does not extend ventrally quite to mid-height. A prominent, large, subcentral node lies slightly dorso-posterior of mid-point of carapace. Surface finely reticulate with coarser reticulations on submarginal flange and along its dorsal base. A slight swelling occurs at the

posterio-ventral corner where submarginal valley ends. A large, oval pit, which is longitudinally elongate lies at the anterio-ventral base of the subcentral node.

Dimensions of type specimen: length, .792 mm.; height, .495 mm.; thickness, .24 mm. (one valve).

Locality: P51A 0803.49. Holotype; Walker Museum, No. 45122.

Remarks: This common Menard species is very similar to *A. bradfordi* (new name for *A. rothi*) of the Clore formation and may prove to be conspecific with it. It differs from *A. bradfordi*, however, in its less elevated anterior lobe, in its peculiar surface reticulations and in its horizontally extended subcentral pit. *A. lineatus* may be distinguished from *A. sublineatus* of the Kinkaid by its much less flared and less sharply delineated anterio-dorsal node, by its differently proportioned outline and by its surface ornamentation. Individuals of this group, however, grade toward the typical *A. sublineatus*.

Genus Kirkbyella Coryell and Booth

Kirkbyella gutkei Croneis and Bristol, n. sp.

Plate IV, figs. 14, 15

Carapace small, subsemicircular to subrectangular in outline; maximum height about two-thirds the length of the shell from the anterior end. Maximum length midway between the dorsal and ventral margins. Maximum height about two-thirds the length of the shell from the anterior end. Dorsal margin straight, ventral margin straight or nearly so, anterior and posterior outlines curve gradually into the venter. Anterio-cardinal angle approximately 100°; anterior outline has a sub-circular swing from the hinge line to the venter; posterio-cardinal angle also approximately 100°, but posterior outline displays a somewhat longer slope into the venter. A low longitudinal ridge occurs on the ventral portion of both valves; this structure slopes off gradually into general shell surface anteriorly, posteriorly it is more pronounced and terminates in a node-like posteriorly pointed elevation a short distance from the posterior margin; entire ridge

lies ventrad of median sulcus. Ventral side of the ridge slopes steeply to the margin; dorsally the ridge slopes off more gently, the slope being more pronounced dorso-posteriorly. The shell is essentially equivalved. Surface reticulate with an elongate pattern modified by the ridge itself. A distinct sulcus occurs a short distance anterior to mid-length. Sulcus is normal to the hinge line or inclined slightly to the front. Length of sulcus about one-third shell height.

Dimensions of type specimen: length, .60 mm.; height, .37 mm.; thickness, .25 mm.

Locality: P66A 0431.92. Holotype, Walker Museum, No. 45123.

Remarks: *Kirkbyella gutkei* of the Menard formation, *K. perplexa* Wilson, *K. unicornis* Coryell and Malkin, and *K. scapha* Morey are all related despite their diverse stratigraphic horizons. They differ in reticulation, in shape, and in lack of a free border from *K. typa* Coryell and Booth and *K. marginopunctata* Wilson. Probably they represent a different genus.

Genus Verrucosella Croneis and Gale

Verrucosella golcondensis Croneis and Gale

Plate IV, fig. 6

Verrucosella golcondensis Croneis and Gale, "New Ostracodes from the Golconda Formation" Den. Univ. Bull., Jour. Sci. Lab., 33, 275–276, pl. V, fig. 8 (1938).

Dimensions of the figured specimen: length, .528 mm.; height, .297 mm.; thickness, .208 mm.

Locality: P66A 0431.92. Hypotype, Walker Museum, No. 45124.

Remarks: This ostracode is referred to *V. golcondensis* of the Golconda formation with a considerable degree of confidence. The major dimensions of the figured specimen are very nearly those of the type, and its nodes are similar in size and general position. The two mid-dorsal elevations, however, are more widely separated in the Menard representative than in the type specimen.

Family Cytherellidae Sars

Genus Cavallina Coryell

Cavallina perplexa Croneis and Funkhouser

Plate III, fig. 17

Cavallina ? perplexa Croneis and Funkhouser, "New Ostracodes from the Clore Formation," Den. Univ. Bull., Jour. Sci. Lab., 33, 359, pl. IX, figs. 19, 20 (1938).

Dimensions of specimen: length, .81 mm.; height .58 mm.; thickness .80 mm.

Locality: P66A 0931.92. Hypotype, Walker Museum, No. 45115.

Remarks: Many Cavallinas are found in the Menard samples and several types are present. *C. cavallina* is the most common. The Cavallinas are a hard group to work with because of their similarity.

Family Glyptopleuridae Girty

Genus Glyptopleura Girty

Glyptopleura carrolli Croneis and Bristol, n. sp.

Plate IV, fig. 20

Carapace subquadrate to subovate in outline; hinge line straight; cardinal angles rounded, posterior more acute than anterior, posterior angle approximately 125°, anterior angle about 130°; posterior ventral swing subequal to the posterior dorsal swing; anterior outline bluntly rounded; posterior outline bluntly pointed. Ventral margin slightly convex; area of maximum height lies about one-third shell length anterior to the posterior margin, shell surface tapering gradually toward anterior end. Surface marked with strong subparallel ribs, which in general trend slightly downward from posterior to anterior. Eight ribs extend from near anterior end, seven from near the posterior margin. First dorso-anterior rib short, extending posteriorly about one-third shell length; second rib somewhat undulant, extending the length of the shell; third rib slightly shorter than the first and has a counter part on the posterior end; fourth rib nearly as long as the second with anterior end

dorsally directed. The fifth rib is shorter than the fourth rib; the sixth rib and the second unite anteriorly to make a "U" within which are implanted the third, fourth and fifth ribs. The seventh rib prominent, but less long than the sixth because ventral swing of shell foreshortens it; for the same reason the eighth rib is shorter than the seventh. Dorsad of mid-carapace is a pit located between the second and fourth ribs; the fourth anterior rib is terminated before the pit as is the third rib on the posterior end.

Dimensions of type specimen: length, .924 mm.; height, .528 mm.; thickness, .31 mm. (one valve).

Locality: Sec. 18 RC/M. Holotype, Walker Museum, No. 45125.

Remarks: This species may be distinguished from its near relative, *G. varicostata* of the Kinkaid formation, in that the later has a short ridge two ribs above the ventral margin, and possesses a more extended upper dorsal rib.

Glyptopleura complexa Croneis and Funkhouser

Plate IV, fig. 25

Glyptopleura complexa Croneis and Funkhouser, "New Ostracodes from Clore Formation," Den. Univ. Bull., Jour. Sci. Lab., 33, 351–352, pl. X, fig. 2 (1938).

Dimensions of figured specimen: Length, .80 mm.; height, .48 mm.; thickness, .20 mm. (one valve).

Locality: P66A 0431.92. Hypotype, Walker Museum, No. 45126.

Remarks: The Menard representatives of this species are perhaps slightly more complex in the details of their rib structure than the type. The mid-rib, for instance, usually shows some slight suggestion of a posterior hook on the Menard specimens.

Glyptopleura conflexacostata Croneis and Gale

Plate IV, fig. 21

Glyptopleura conflexacostata Croneis and Gale, "New Ostracodes from Golconda Formation," Den. Univ. Bull., Jour. Sci. Lab., 33, 278–279, pl. VI, fig. 7 (1938).

Dimensions of figured specimen: length, .693 mm.; height, .396 mm.; thickness, .18 mm. (one valve).

Locality: P66A 0431.92. Hypotype, Walker Museum, No. 45127.

Remarks: Although many Menard specimens are similar to *G. conflexacostata* only one valve has been found which can be referred with certainty to that species. This is approximately the same size as the type.

Glyptopleura hamatilis Croneis and Bristol, n. sp.

Plate IV, fig. 22

Carapace suboblong to subovate in outline, thick; hinge line straight or very slightly concave. Cardinal angles subequal, with anterior outline more round than posterior. Both ends of the carapace round nearly uniformly into the venter. The most prominent marking is a double rib, extending in a sub-median posterio-anterior line; posterior portion of double rib forms a "U," whereas the anterior ends join the larger, oppositely directed outside "U," which extends from dorsal to ventral margins. Enclosed by this elongate subovate structure is a rib, approximately paralleling the major ribs, which terminates posteriorly in a hook whose termination is dorsad of rib itself. Ventrad to the prominent rib lies a fifth rib having the configuration of the former. The latter extends anteriorly into the anterior or major "U." The sixth rib is the ventrad arm of the major "U." Thickest point of shell subanterior-central to hook of enclosed rib.

Dimensions of type specimen: length, .729 mm.; height, .429 mm.; thickness, .23 mm. (one valve).

Locality: P66A 0431.92. Holotype, Walker Museum, No. 45128.

Remarks: *G. hamatilis* is to *G. pentacostata* of the Golconda formation except its hook is reversed, and its ventral and dorsal ribs form the larger "U." The Menard species is also very similar to *G. conflexacostata* of the Golconda formation except that the latter has no hooked rib, and its ribs are generally

coarser. *G. complexa* of the Clore formation is a still closer relative, and a gradational series may be arranged between Menard specimens which can be referred with some certainty to that species and to *G. hamatilis*. *G. elliptica* of the Renault formation and *G. schizopleura* Coryell and Sohn of the Reynolds formation of West Virginia also belong to the same glyptopleurid clan.

Glyptopleura harltoni Croneis and Bristol, n. sp.

Plate IV, fig. 26

Carapace subquadrate to subovate in outline, medium sized; hinge line straight or nearly so, depressed; cardinal angles obtuse; anterior cardinal angle less rounded than posterior angle; anterior and posterior outlines broadly and subequally rounded, posterior ventral slope somewhat longer and less uniformly rounded than anterior ventral swing; ventral outline slightly convex but subparallel to hinge line. Highest point of carapace posterior to mid-line; greatest height sub-central. Ventral and dorsal margins flanged. Surface marked by strong, sub-parallel ribs, which trend slightly upward from anterior to posterior. First ridge ventrad of ribbed dorsal margin interrupted and depressed near mid-point to a pit-like sulcus. The anterior portion of this rib, and the rib next to the bottom, form a "U" whose base is anterior and essentially parallel to the anterior outline; second dorsal rib undulant, extends almost completely across shell; the short third anterior rib lies just anterior to a large pit. Fourth rib is shaped like a "J" with posterior portion of "hook" turned upward and then back toward the anterior. Fifth rib similar in alignment to the fourth, but shorter and without the reflexed portion. The seventh rib from the dorsum, which, in general, is the ventral extension of the first dorsal ridge, is subparallel to but longer than, the sixth ridge. A small rib just anterior to mid length lies between the seventh ridge and a ventral rib extending roughly the length of the shell.

Dimensions of type specimen: length, 1.02 mm.; height, .57 mm.; thickness .28 mm. (one valve).

Locality: 022814 No. 5 (b). Holotype, Walker Museum, No. 45129.

Remarks: *Glyptopleura harltoni* is closely related to *G. adunca* of the Kinkaid formation. In *G. harltoni*, however, the second rib has both anterior and posterior upswings or bows, separated by a ventrally directed undulation just above and posterior to the pit.

Glyptopleura intermedia ? Croneis and Gale

Glyptopleura intermedia, Croneis and Gale, "New Ostracodes from Golconda Formation," Den. Univ. Bull., Jour. Sci. Lab. 33, 279, pl. VI, fig. 6 (1938).

Dimensions of a typical specimen: length, .60 mm. (broken); height, .37 mm.; thickness, not determinable.

Locality: Sec. 18 RC/M.

Remarks: Referred to the Golconda formation species, *G. intermedia*, with considerable doubt although the forms are unquestionably closely related. The Menard representatives which are in fragmentary condition, do not show the second faint rib implanted in the "U."

Glyptopleura kayi Croneis and Bristol, n. sp.

Plate IV, fig. 23

Carapace subovate in outline, hinge line slightly concave, rising highest at anterior cardinal angle; posterior cardinal angle more obtuse and less definite than anterior; posterior ventral swing more abrupt than anterior. Surface marked by strong sub-parallel ribs, which rise only slightly from anterior to posterior. Dorsal rib composed of two subequal dorsally bowed segments separated by a prominent depression. Prominent second rib extends from anterior border to unribbed area near posterior end. Ribs dorsad to mid-line show a ventrad swing at anterior margin. Third rib in two segments, like the first, but with posterior segments more prominent than anterior one. Fourth rib prominent with a slight mid-carapace swing toward dorsum. Fifth and sixth ribs similar in strength and inflexion to fourth. Seventh rib sub-parallel to the ventral outline and

neither so extended posteriorly nor so strong as the sixth rib. Dorsal margin of the carapace marked by a flange or ridge.

Dimensions of type specimen: length, .859 mm.; height, .528 mm.; thickness, .28 mm.

Locality: C6 (b). Holotype, Walker Museum, No. 45130.

Remarks: *G. kayi* resembles *G. reniformis* of the Kinkaid formation, but may be distinguished from that species by its larger unribbed posterior end; *G. reniformis* also possesses one more ventral rib. *G. kayi* is related to *G. pseudosulcata* of the Kinkaid formation, but the Menard species is less rectilinear in outline and lacks completed "U" structure of the ribs.

Glyptopleura resupinata Croneis and Bristol, n. sp.

Plate IV, fig. 24

Carapace medium sized, subquadrate to subovate in outline, hinge line straight or nearly so. Cardinal angles subequal, approximating 135°; posterio-ventral and anterio-ventral swings subequal; venter only slightly concave. Surface marked by a series of irregularly placed sub-parallel ridges which tend to rise slightly from anterior to posterior. First anterior dorsal rib short, extending but half way across carapace; from near its termination a narrow ridge extends from mid-line to near posterior cardinal angle. The second dorso-anterior rib extends anteriorly from a little short of mid-line to near middle of anterior margin, where it turns sharply backward and extends just below mid-line of carapace to posterior end, where it again bends back upon itself and extends to within a short distance of its anterior bend. Above this rib are two small ridges of about equal length separated by a pit located somewhat above midpoint of carapace. Ventrad of the reflexed major rib is another major rib extending from near anterior to near posterior margins. Rib shows a slight dorsal rise near mid-carapace and is turned upwards at both ends. Below this major ornament is a shorter centrally placed rib about two thirds the length of the bordering rib above. Beneath this short rib is still another ridge which extends from posterior to anterior margins. Dorsal and ventral

margins slightly rimmed; both ends smooth without indication of a rim.

Dimensions of type specimen: length, .957 mm.; height, .549 mm.; thickness, .30 mm.

Locality: 022814 No. 13 (b). Holotype, Walker Museum, No. 45131.

Remarks: *G. resupinata* is like *G. symmetrica* of the Clore formation but its ribs are arranged differently. *G. resupinata* is characterized by the two small ribs flanking the central pit and by the resupinate central rib system.

Genus Glyptopleurina Coryell

Glyptopleurina complexa Croneis and Bristol, n. sp.

Plate IV, fig. 16

Carapace sub-semicircular to subovate in outline; hinge line straight to slightly convex; cardinal angles obtuse; anterior angle approximately 135°; posterior approximately 130°; anterior ventral swing longer than posterior swing which rounds smoothly into slightly convex venter. Broad median sulcus expanded dorsally. Anterior to sulcus is an inverted question mark whose base is directed backward below the forward directed base of a less regular posterior question mark. Behind posterior question mark is a flat topped ridge which becomes very broad in the ventro-posterior quarter. Anteriorly this structure breaks up into three separate ridges, the dorsal portion being the base of the anterior question mark; the middle portion is a short rib parallel to the one above it; the broader topped ventral portion is subparallel to the anterio-ventral slope and extends dorsally about to mid height. Shell has a conspicuous flat border around free margin. Surface smooth; greatest thickness ventro-posterior of mid point.

Dimensions of type specimen: length, 96 mm.; height, 65 mm.; thickness, .32 mm. (right valve crushed into left valve).

Locality: 022814 No. 7 (b). Holotype, Walker Museum, No. 45132.

Remarks: *Glytopleurina complexa* is the most unusual member of the genus yet described. In the flat-topped character of some of its ribs it shows similarities to the surface markings of *Idiomorphina*.

Glyptopleurina simplex Croneis and Bristol, n. sp.

Plate IV, fig. 19

Carapace medium sized, hinge line straight; cardinal angles obtuse, anterior angle less obtuse than posterior; anterior outline somewhat bluntly rounded. An elongate, swollen crescent-shaped lobe extends obliquely upward from just behind anterio-ventral swing to just below posterior cardinal angle. This structure outlines a deep and fairly narrow sinus ventrally, posteriorly, and partly on the anterior. Two oval swellings lie one on each side of a dorsally and ventrally expanded sulcus. The posterior node is ventrically elongate, the anterior node is longitudinally expanded. A thin ventral ridge lying above the crescent shaped lobe connects the ventral portion of the posterior node to the mid ventral portion of the anterior node. A distinct outer ridge outlines the free margin. Surface very finely reticulate.

Dimensions of type specimen: length, .848 mm.; height, .495 mm.; thickness, .20 mm. (crushed).

Locality: P66A 0431.92. Holotype, Walker Museum, No. 45133.

Remarks: The specimen illustrated is somewhat crushed. *G. simplex* may be distinguished from *G. complexa* on the basis of the difference in surface markings.

The Menard representatives of this genus, however, are considerably different from the genotype, and they are referred to *Glyptopleurina* with some doubt. The species in question have a vague similarity to *Idiomorphina oehersi* from the same formation, and even to *Golcondella sulcata* from the Golconda. The genera involved are as suggestive of the *Zygobolbinae* as they are of the *Glyptopleuridae*, and their family position at present remains uncertain.

Genus Idiomorphina Croneis and Gale

Idiomorphina oehersi Croneis and Bristol, n. sp.

Plate IV, fig. 17

Carapace medium sized, subovate in outline; dorsal outline essentially straight; greatest height somewhat anterior to mid-carapace. Posterior cardinal angle indefinite, approximating 140°; posterior outline rounds into venter smoothly and uniformly. Anterior cardinal angle approximately 110°; dorso-anterior outline almost straight, anterio-ventral outline uniformly rounded. Dorsad to and slightly anterior of center is a deep sulcus. Anterior lobe divided into two unequal portions by a linear depression, extending first ventrally, then posteriorly along the general mid-line of the carapace. A ridge extends from the inner and larger division of the anterior lobe ventrally then posteriorly to the posterior lobe. A less prominent ridge extends from top of the posterior lobe ventrally, then anteriorly along the crest of the swelling. The anterior swelling and its posteriorly extended ridge resemble the conventional outline of a pipe; the ventro-posterior ridge resembles an inverted "J." The carapace, as a whole, is wedge-like, becoming gradually thinner from posterior to anterior end. The anterior end is marked by a relatively conspicuous border.

Dimensions of type specimen: length, .848 mm.; height, .495 mm.; thickness, .330 mm.

Locality: P66A 0431.92. Holotype, Walker Museum, No. 45134.

Remarks: Specimens referred to this species show variation in strength of ornamentation and in the bluntness of the anterior end. One individual seems to possess a slight remnant of a frilled border along anterior margin.

Idiomorphina oehersi is closely related to *I. insignis* of the Golconda formation. The latter species, however, is proportionally longer and has surface markings which although similar in kind, are considerably different in size and placement.

Idiomorphina is a new name for Idiomorpha, preoccupied, 1869.

Family Bairdiidae Sars

Genus Bairdia McCoy

Bairdia golcondensis Croneis and Gale

Plate III, fig. 20

Bairdia golcondensis Croneis and Gale, "New Ostracodes from the Golconda Formation," Den. Univ. Bull., Jour. Sci. Lab., 33, 286, pl. VI, figs. 26–27 (1938).

Dimensions of figured specimen: length, .70 mm.; height, .38 mm.; thickness, .37 mm.

Locality: C4 (C). Hypotype, Walker Museum, No. 45135.

Remarks: A number of representatives of the genus *Bairdia* occur in the Menard as well as in other Chester formations, but most of them are non-distinctive types apparently of no great stratigraphic value. The specimens referred doubtfully to *B. golcondensis* Croneis and Gale are similar in size and overlap to the type of that species, but their posterior outline is more blunt, and their greatest length is more nearly at mid-height of shell.

Genus Bairdiolites Croneis and Gale

Bairdiolites bulbosus Croneis and Gale, n. sp.

Plate III, figs. 14–15

Carapace subrhomboidal, medium sized; left valve overlaps right except at anterior cardinal angle, anterior end blunt to within a short distance ventrad of mid-height where it begins to swing into venter; venter straight to slightly concave with a slight posterior rise. Dorso-posterior slopes precipitously to beak near which it is slightly concave on left valve; markedly so on right valve. Hinge line shows overlap of the left valve on the right beginning just anterior to mid-height and extending to anterior cardinal angle. Overlap of left valve also notable at posterior cardinal angle; overlap of beak by left valve complete; overlap strongest on venter. Two curved ridges on each valve, one anterio-central, the other posterio-central. Surface generally smooth. Greatest thickness near mid-carapace.

Dimensions of type specimen: length, .79 mm.; height, .46 mm.; thickness, .30 mm.

Locality: C6 (C). Holotype, Walker Museum, No. 45136.

Remarks: *B. bulbosus* is somewhat similar to *B. crescentis* of the Golconda formation, but it is different in outline and especially in its dorsal overlap. It also resembles *B. platypleurus* of the Golconda, but differs in hinge character, overlap, and outline. Furthermore the Menard species has the inter ridge area less strongly marked by a pebble-like surface. *B. bulbosus* is less ovate in outline than *B. ovatus* of the Clore formation and differs from that species in its overlap.

Bairdiolites crescentis Croneis and Gale

Plate III, fig. 18

Bairdiolites crescentis Croneis and Gale, "New Ostracodes of the Golconda Formation," Den. Univ. Bull., Jour. Sci. Lab. 33, 288, pl. 6, figs. 19–20 (1938).

Dimensions: length, .69 mm.; height, .34 mm.; thickness, .30 mm.

Locality: P66A 0431.92. Hypotype, Walker Museum, No. 45137.

Remarks: A number of specimens from the Menard are referred to *B. crescentis* of the Golconda formation with considerable confidence.

Bairdiolites emarginatus Croneis and Bristol, n. sp.

Plate III, figs. 12, 13

Carapace subovate in outline; length about 1.5 times the height. Left valve overlaps right inconspicuously around entire margin; overlap slightly more pronounced on dorsum than on venter. Dorsal outline broadly subtriangular; slope from area of greatest height to posterior cardinal angle more rounded than anterior slope; posterior dorsal slope notably concave; anterio-ventral slope well rounded, meets venter at an angle; venter straight, rising gradually toward the rear, finally rounding into short but fairly sharp beak which lies below mid-height. The smaller

right valve essentially the same as the left in outline. Hinge line bowed from right to left valve when seen in dorsal view. Ridges suggest a nearly circular surface structure but are not united either dorsally or ventrally. Surface inside ridges pitted, outside of ridges smooth. Area inside ridges on right valve usually more flattened than area on left shell. Greatest height and thickness near mid-carapace.

Dimensions of type specimen: length, .66 mm.; height, .40 mm.; thickness, .27 mm.

Locality: P66A 0431.92. Holotype, Walker Museum, No. 45138.

Remarks: *B. emarginatus* is similar to *B. ovatus* of the Clore formation except that its dorsal outline is more angulated, its dorso-posterior slope is much more concave, its ridges are somewhat more prominent and the inter ridge area far more flattened. *Bairdialites* is well represented in the Menard formation but individual variation is so great that we hesitate at this time to erect additional species.

Genus Healdia Roundy

Healdia goniapleura Croneis and Bristol, n. sp.

Plate III, fig. 22

Carapace subovate to subtriangular in outline; dorsal margin gently and subregularly bowed; anterior outline less uniformly rounded than posterior, and swinging backward a little below rather indistinct anterior cardinal angle. Venter straight to slightly concave. Left valve larger, overlapping right completely, but inconspicuously at the posterior; overlap greatest on venter and dorso-anterior slope. A semicircular subangulated ridge occurs on the posterior half of the carapace; ridge "C" shaped and roughly conforming to posterior outline of shell: upper arm of "C" longer than lower portion. Greatest thickness posterior; surface slopes gently from this thickened area to anterior end, slope steep from ridge to posterior margin. Surface smooth.

Dimensions of type specimen: length, .60 mm.; height, .37 mm.; thickness, .25 mm.

Locality P66A 0431.92. Holotype, Walker Museum, No. 45139.

Remarks: *H. goniapleura* is common in the Menard formation. It resembles *H. simplex* of the Graham formation in outline, but its ridge is different in shape, and the shell slopes are not alike.

Healdia ? *menardensis* Croneis and Bristol, n. sp.

Plate III, fig. 28

Carapace small, subovate; hinge line arched, posterior cardinal angle approximately 110° and well defined; anterior cardinal angle approximately 135° and indefinite; venter straight or nearly so; dorso anterior slope continuing unbroken into the dorsum; anterio-ventral swing well rounded, posterior outline bluntly triangular; posterio-ventral swing makes an angle of about 120° with the venter. A small sulcus is located slightly dorso-posterior of mid-carapace. Anterior half of shell rimmed; rim bordered posteriorly by a vague depression parallel to the anterior outline. A blunt node occurs near the posterior cardinal angle, and a similar elevation marks the posterior junction of the outline with the venter. Greatest thickness slightly posterior to sulcus from which raised area of shell slopes off gradually dorsally, anteriorly and posteriorly; ventrally there is a sharp break in shell slope. Strongest surface faintly reticulate, reticulation strongest posteriorly.

Dimensions of type specimen: length, .396 mm.; height, .264 mm.; thickness, .15 mm.

Locality: P66A 0431.92. Holotype, Walker Museum, No. 45140.

Remarks: This species differs from the common representatives of the genus in the character of its nodes, which project at right angles to the plane of the valve instead of posteriorly, in possessing a sulcus, and in having a reticulated surface. When more material comes to light undoubtedly a new genus will have to be erected for such ostracodes. *H. triangularis* of the Golconda formation also has a sulcus-like depression, but it is far less pronounced and it is located dorso-anteriorly.

Genus Macrocypris Brady

Macrocypris chapmani Croneis and Bristol, n. sp.

Plate III, fig. 19

Carapace small, subtriangular in outline; hinge line convex; venter nearly straight to slightly convex posteriorly, slightly concave midway between anterior and posterior ends. Right valve slightly the larger, overlaps left noticeably only on dorsum from beak to posterior cardinal angle. Anterior end rather sharply pointed; posterior outline uniformly rounded, with curvature unbroken from dorsum into venter. Anterior outline slightly concave, beak bluntly pointed. Greatest thickness slightly anterior of mid-shell; greatest length below mid-height. Surface smooth.

Dimensions of type specimen: length, .660 mm., height, .363 mm., thickness, .264 mm.

Locality P66A 0431.92. Holotype, Walker Museum No. 45141.

Remarks: *M. chapmani* is similar to *M. menardensis* from the Graham formation but it is proportionally shorter and higher. The Menard species is notable for its lack of pronounced overlap.

Genus Seminolites Coryell

Seminolites sohni Croneis and Bristol n. sp.

Plate III, figs. 26, 27

Carapace roughly triangular to subovate in lateral view; maximum height near mid-carapace, greatest length along mid-dorso-ventral line; maximum thickness near mid-carapace. Hinge line arched; anterior and posterior slopes from mid-dorsum subequal, the anterior slope being slightly shorter. Anterior and posterior dorsal slopes extend out from the hinge line without a definite break in the curve. Greatest shell extension anteriorly near venter, greatest shell extension posteriorly is near mid-height. Venter straight or very slightly concave; more concavity in right valve than in left. Left valve the larger; overlaps the right ventrally and at both ends; posterior overlap greater than

anterior; ventral overlap greater than at either end. Anterior ridge distinct, close to anterior end; ridge extends from beginning of anterior cardinal swing toward ventral margin; posterior ridge small and inconspicuous, about half the length of the anterior ridge, not as high and slopes off gradually to the posterior margin. Surface very finely and subregularly pitted; not as marked by large circular pits as in the genotype.

Dimensions of type specimen: length, .528 mm.; height, .330 mm.; thickness, .270 mm.

Locality: P66A 0431.92. Holotype, Walker Museum, No. 45142.

Remarks: *S. sohni* is somewhat similar to *S. subtriangularis* of the Wapanucka formation, but it is not as triangular in outline, its posterior ridge is stronger, it shows no dorsal over-lap.

Family Youngiellidae Kellett

Genus Youngiella Jones and Kirkby

Youngiella rhomboidalis Croneis and Bristol, n. sp.

Plate III, fig. 23

Carapace small, apparently equivalved, subrhomboidal; corners rounded, maximum length along midline of shell; maximum height near posterior end, maximum thickness near mid-carapace. Dorsal margin commonly straight, in some specimens slightly arched near mid-dorsum. Ventral margin straight and subparallel dorsal outline, but commonly sloping slightly toward the posterior. Anterior cardinal angle about 105°; posterior cardinal angle about 120°. Anterior cardinal angle rounded; posterior cardinal swing elliptical, swings out above mid-height below which it swings abruptly backward. Alternating teeth and sockets not definitely seen, but presumably present. Shell thickest near the hinge line; surface marked by numerous small pits some of which serrate the inner edge of border. Border extends the length of the free margin, smooth, generally marked by a color contrast elevated above the rest of the shell.

Dimensions of type specimen: length, .495 mm.; height, .231 mm.; thickness, .10 mm. (one valve).

Locality: P66A 0431.92. Holotype, Walker Museum No. 45143.

Remarks: There are probably several species of this genus present in the Menard formation. *Y. rhomboidalis* is similar to *Y. knighti* Wilson, *Y. spicifera* Wilson, and *Y. puncta* Wilson, all from the Birdsong formation, but the Menard species has surface ornamentation which distinguishes it from the older representatives of the genus. *Y. rhomboidalis* also lacks a spine.

BIBLIOGRAPHY

Bassler, R. S., and Kellett, Betty, "Bibliographic Index of Paleozoic Ostracoda." *Geological Society of America*, Special Papers, No. 1 (1934). This index is arranged by periods and formations as well as by species. References to most ostracode papers published prior to January 1, 1934, are included in it.

Cooper, C. L., "Ammonium Chloride Sublimate Apparatus." *Journal of Paleontology 9*, 357–359 (1935).

Coryell, H. N., and Sohn, I. G., "Ostracoda from the Mauch Chunk Mississippian of West Virginia." *Journal of Geology 12*, 596–603 (1938).

Croneis, Carey, and Funkhouser, Harold, "New Ostracodes from the Clore Formation." *Den. Univ. Bull., Jour. Sci. Lab. 33*, 331–361 (1938).

Croneis, Carey, and Gale, Arthur S., Jr., "New Ostracodes from the Golconda Formation." *Den. Univ. Bull., Jour. Sci. Lab. 33*, 251–297 (1938).

Croneis, Carey, and Thurman, Franklin A., "New Ostracodes from the Kinkaid Formation." *Den. Univ. Bull., Jour. Sci. Lab. 33*, 297–331 (1938).

Croneis, Carey, and Gutke, Ralph L., "New Ostracodes from the Renault Formation." *Den. Univ. Bull., Jour. Sci. Lab. 34*, 33–63 (1939).

Harris, R. W., and Worrell, Frank, "A Fossiliferous Horizon from the Lower Permian of Caddo County, Oklahoma." *Journal of Paleontology 10*, 518–519 (1936).

Kellett, Betty, "Ostracodes from the Upper Pennsylvanian and Lower Permian Strata of Kansas: II. The Genus Bairdia." *Journal of Paleontology 8* 120–138, pls. 14–19 (1935).

——— "Ostracodes from the Upper Pennsylvanian and the Lower Permian Strata, of Kansas: III. Bairdiidae (concluded), Cytherellidae, Cypridinidae, Entomoconchidae, Cytheridae, and Cypridae." *Journal of Paleontology 9*, 132–166, pls. 16–18 (1935).

Morey, Philip S., "Ostracoda from Basal Mississippian Sandstone in Central Missouri." *Journal of Paleontology 9*, 316–326, pl. 28 (1935).

——— "Ostracoda from the Amsden Formation of Wyoming." *Journal of Paleontology 9*, 474–482 (1935).

——— "Ostracoda from the Chouteau Formation of Missouri." *Journal of Paleontology 10*, 114–122, pl. 17 (1936).

Roundy, P. V., Girty, G. H., and Goldman, M. I., "Mississippian Formations of San Saba County, Texas." *U. S. Geol. Surv. Prof. Paper No. 146*, pp. 5–17 (1926).

SWARTZ, F. M., "Revision of the Primitiidae and Beyrichiidae with New Ostracoda from the Lower Devonian of Pennsylvania." *Journal of Paleontology 10*, 541–586, pls. 78–89 (1936).

ULRICH, E. O., "Some New Facts Bearing on Correlations of Chester Formations." *Bull. G. S. A. 33*, 805–852 (1922).

WELLER, STUART, "The Geology of Hardin County." *Illinois State Geological Survey, Bull. No. 41*, 178–187 (1920).

WELLER, STUART, "The Chester Series in Illinois." *Journ. of Geol. 28*, 395–416 (1920).

PLATES

EXPLANATION OF PLATE III

(All magnifications are approximations accurate to within 4 per cent)

Figs. 1–3. *Carboprimitia depressa* Croneis and Funkhouser, fig. 1, right valve, fig. 2, dorsal view, fig. 3, left valve, × 30.

Fig. 4. *Carboprimitia simulans* Croneis and Thurman, right valve, × 30.

Figs. 5–7. *Sansabella johnsoni* Croneis and Thurman, fig. 5, left valve, fig. 6, right valve, fig. 7, dorsal view, × 30.

Fig. 8. *Carboprimitia spinosa* Croneis and Bristol, n. sp.; right valve, × 30.

Fig. 9. *Jonesina lalickeri* Croneis and Bristol, n. sp.; fig. 12, left valve, fig. 13, dorsal view, × 30.

Figs. 10–11. *Jonesina intermedia* Croneis and Bristol, n. sp.; left valve, × 30.

Figs. 12–13. *Bairdiolites emarginatus* Croneis and Bristol, n. sp.; left valve, × 30.

Figs. 14–15. *Bairdiolites bulbosus* Croneis and Bristol, n. sp.; fig. 14, right valve, fig. 15, dorsal view, × 30.

Fig. 16. *Perprimitia matheri* Croneis and Bristol, n. sp.; right valve, × 30.

Fig. 17. *Cavallina perplexa* Croneis and Funkhouser, left valve, × 30.

Fig. 18. *Bairdiolites crescentis* Croneis and Gale, right valve, × 30.

Fig. 19. *Macrocypris chapmani* Croneis and Bristol, n. sp.; right valve, × 30.

Fig. 20. *Bairdia golcondensis* Croneis and Gale, right valve, × 30.

Fig. 21. *Deloia spinosa* Croneis and Bristol, n. sp.; left valve, × 30.

Fig. 22. *Healdia goniapleura* Croneis and Bristol, n. sp.; right valve, × 30.

Fig. 23. *Youngiella rhomboidalis* Croneis and Bristol, n. sp.; right valve, × 30.

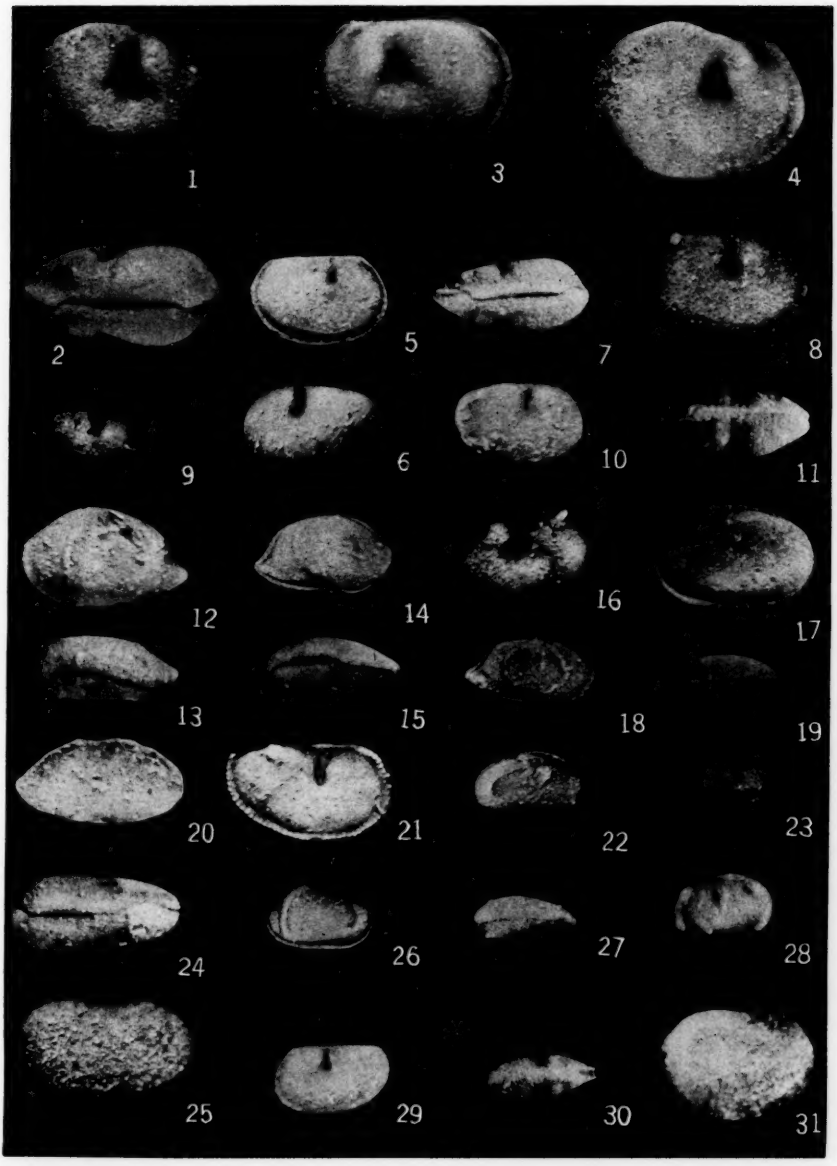
Figs. 24–25. *Neokloedenella secunda* Croneis and Bristol, n. sp.; fig. 24, dorsal view, fig. 25, right valve, × 30.

Figs. 26–27. *Seminolites sohni* Croneis and Bristol, n. sp.; fig. 26, right valve, fig. 27, dorsal view, × 30.

Fig. 28. *Healdia ? menardensis* Croneis and Bristol, n. sp.; fig. 29, right valve, fig. 30, dorsal view, × 30.

Figs. 29–30. *Jonesina consimilis* Croneis and Bristol, n. sp.; fig. 29, right valve, fig. 30, dorsal view, × 30.

Fig. 31. *Microparaparchites inornatus* Croneis and Bristol, n. sp.; righ t valve, × 35.


1
3
4
2
5
7
8
9
6
10
11
12
14
16
17
13
15
18
19
20
21
22
23
24
26
27
28
25
29
30
31

EXPLANATION OF PLATE IV

(All magnifications are approximations accurate to within 4 per cent)

Figs. 1–2. *Amphissites lineatus* Croneis and Bristol, n. sp.; fig. 1, right valve, fig. 2, dorsal view, × 30.

Fig. 3. *Kirkbya fossula* Croneis and Bristol, n. sp.; right valve, × 35.

Fig. 4. *Amphissites decipiens* Croneis and Bristol, n. sp.; left valve, × 30.

Fig. 5. *Amphissites costellifera* Croneis and Bristol, n. sp.; right valve, × 30.

Fig. 6. *Verrucosella golcondensis* Croneis and Gale, left valve, × 30.

Fig. 7. *Amphissites latinodus* Croneis and Bristol, n. sp.; right valve, × 30.

Figs. 8–9. *Amphissites concavus* Croneis and Bristol, n. sp.; fig. 8, left valve, fig. 9, dorsal view, × 30.

Fig. 10. *Amphissites elongatus* Croneis and Bristol, n. sp.; left valve, × 30.

Figs. 11–12. *Microparaparchites spinosus* Croneis and Gale, fig. 11, left valve, fig. 12, right valve, × 30.

Fig. 13. *Denisonia cincta* Croneis and Bristol, n. gen., n. sp.; left valve, × 30.

Figs. 14–15. *Kirkbyella gutkei* Croneis and Bristol, n. sp.; fig. 14, left valve, fig. 15, right valve, × 30.

Fig. 16. *Glyptopleurina complexa* Croneis and Bristol, n. sp.; left valve, × 30.

Fig. 17. *Idiomorphina oehersi* Croneis and Bristol, n. sp.; left valve, × 30.

Fig. 18. *Hollinella moreyi* Croneis and Bristol, n. sp.; right valve, × 30.

Fig. 19. *Glyptopleurina simplex* Croneis and Bristol, n. sp.; left valve, × 30.

Fig. 20. *Glyptopleura carrolli* Croneis and Bristol, n. sp.; left valve, × 30.

Fig. 21. *Glyptopleura conflexacostata* Croneis and Gale, right valve, × 30.

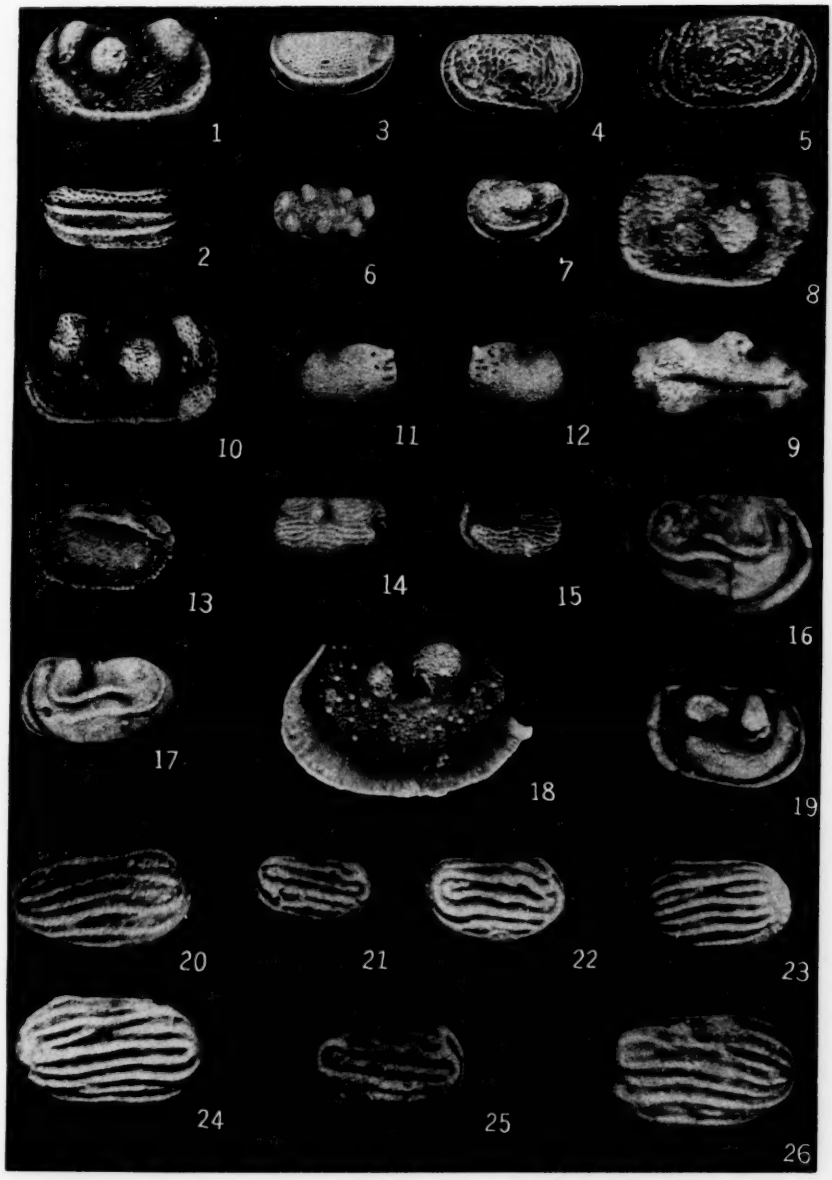
Fig. 22. *Glyptopleura hamatilis* Croneis and Bristol, n. sp.; right valve, × 30.

Fig. 23. *Glyptopleura kayi* Croneis and Bristol, n. sp.; left valve, × 30.

Fig. 24. *Glyptopleura resupinata* Croneis and Bristol, n. sp.; left valve, × 30.

Fig. 25. *Glyptopleura complexa* Croneis and Bristol, n. sp.; right valve, × 30.

Fig. 26. *Glyptopleura harltoni* Croneis and Bristol, n. sp.; left valve, × 30.


1
3
4
5
2
6
7
8
10
11
12
9
13
14
15
16
17
18
19
20
21
22
23
24
25
26

PIONEERING IN YENESEILAND[1]

A Transect Across Siberia from Mongolia to the Arctic

GEORGE B. CRESSEY

Received June 19, 1939; published September 9, 1939

CONTENTS

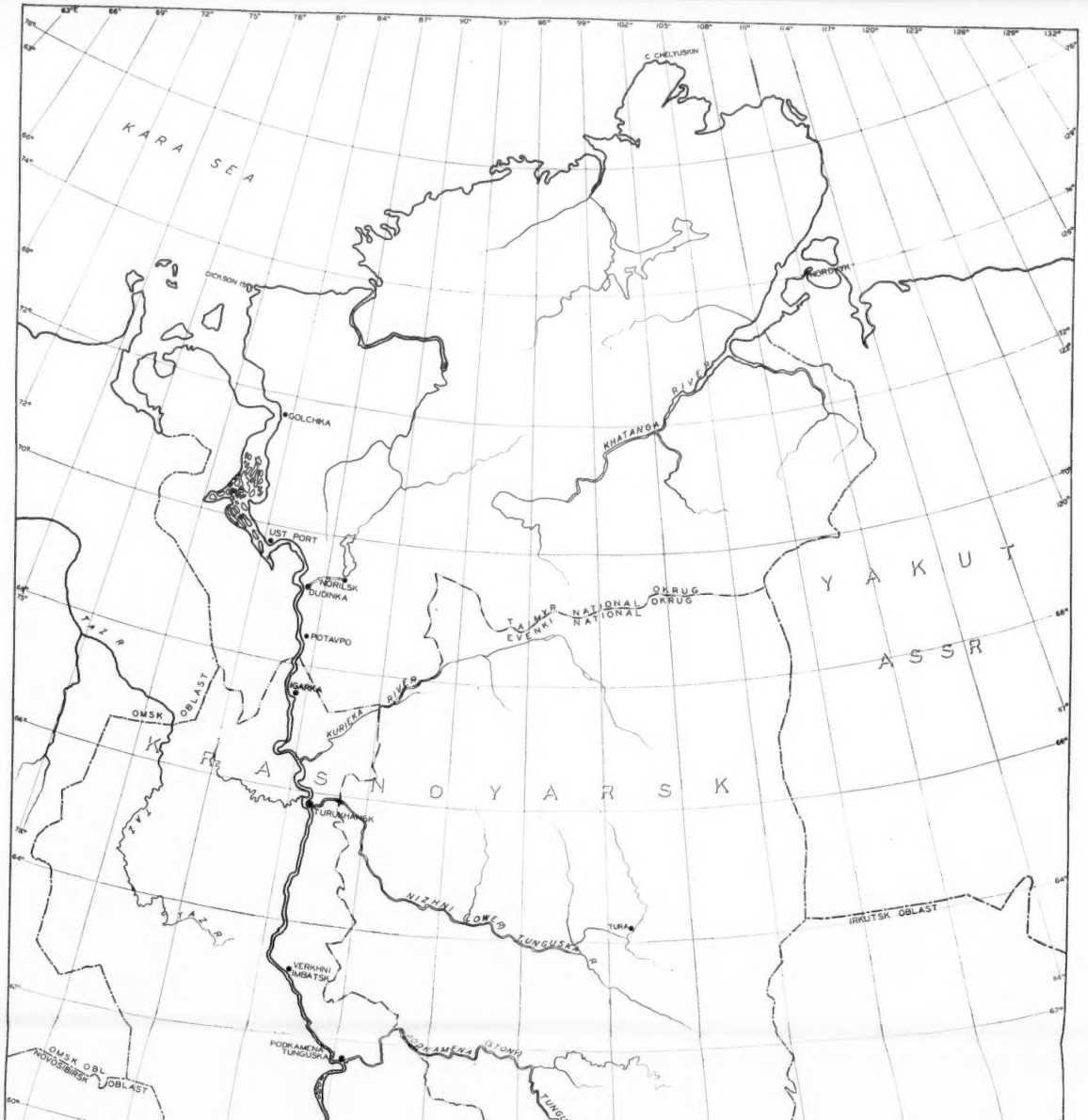
I. Introduction 103
II. Exploration and Settlement 107
III. Transportation by Land, Water, and Air 110
IV. The Sayan Mountains 114
V. The Minusinsk Lowlands 117
VI. The Central Agricultural Region 126
VII. The Taiga 138
VIII. The Arctic Fringe 154
IX. Bibliography 163
X. Transect from the Arctic to Tanna Tuva 164

I. INTRODUCTION

Midway between Poland and the Pacific, the Yenesei River cuts across the Soviet Union from the Tanna Tuva border to the Polar sea. Within the million square miles of its basin are representatives of the mountains, steppes, farm lands, forests, tundras, and Arctic wastes which give character to the Siberian landscape. The Yenesei valley is one of the major economic and political units of Soviet Asia, but within it are half a dozen diverse geographic regions.

Three great rivers flow north across Siberia to the Arctic: the Ob, Yenesei, and Lena. Each of these has its individuality. The valley of the northern Ob is swampy and that of the south is semi-arid; only the central portion near the Trans-Siberian Railway is developed. The Lena flows through the mountainous northeast and unlike the other two is not crossed by a railroad so

[1] Based on field work in 1923 (on the Selenga River), and in 1937 under the auspices of the XVII International Geological Congress (south of Krasnoyarsk) and the Northern Sea Route Administration (north of Krasnoyarsk).


KARA SEA
C. CHELYUSKIN
DIKSON ISD.
GOLCHIKA
KHATANGA RIVER
NORILSK
DUDINKA
UST PORT
POTAVPO
GARKA
TAZ R.
OMSK OBLAST
KURIKA RIVER
TAIMYR NATIONAL OKRUG
EVENKI NATIONAL OKRUG
YAKUT ASSR
KRASNOYARSK
TURUKHANSK
WIZHNI TUNGUSKA R.
TURA
IRKUTSK OBLAST
VERKHNI IMBATSK
PODKAMENNA TUNGUSKA
PODKAMENNA TUNGUSKA R.
OMSK OBL
NOVOSIBIRSK OBLAST

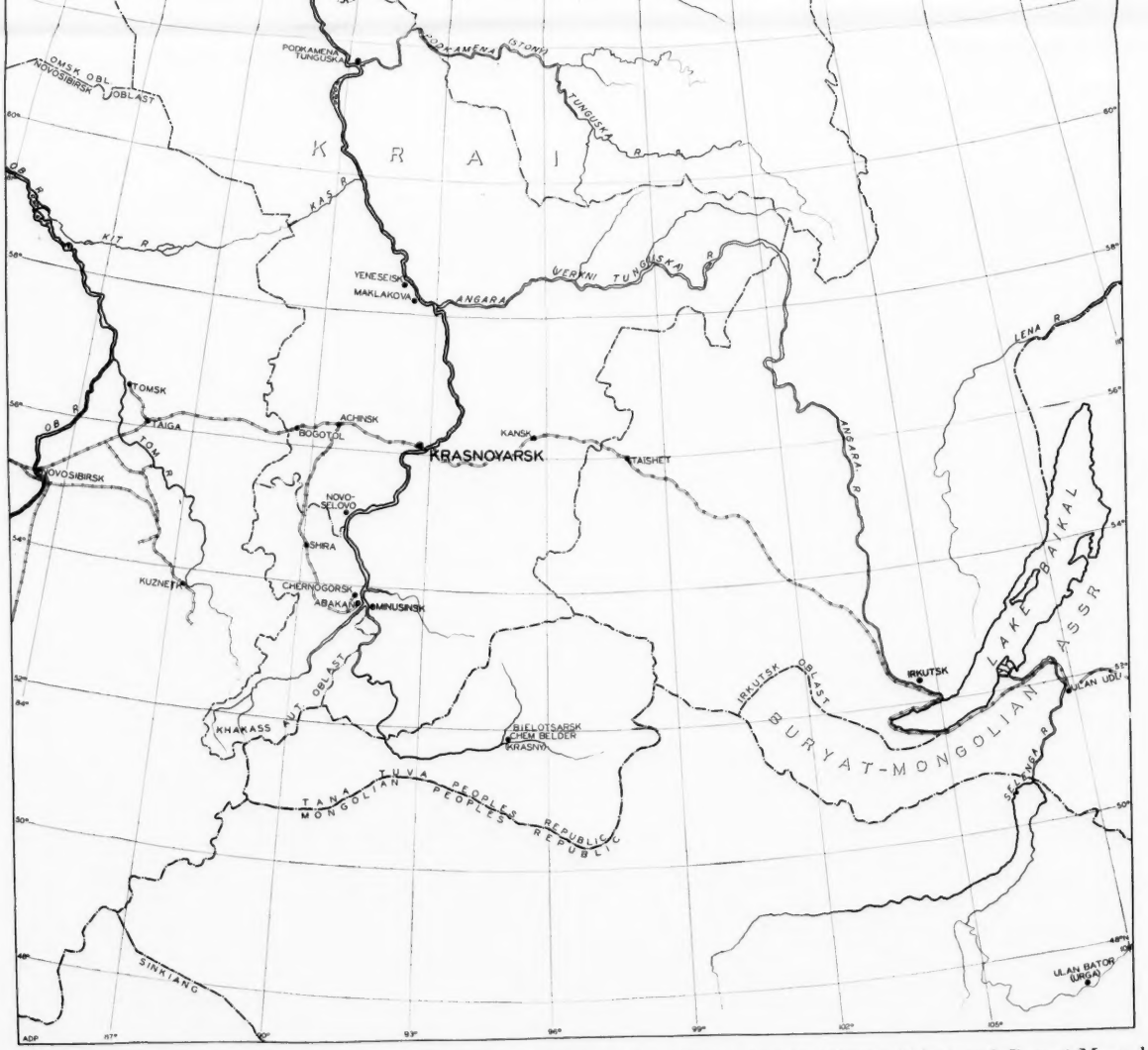


FIG. 1. Most of Yeneseiland lies within Krasnoyarsk Krai, with portions in the Irkutsk Oblast and Buryat-Mongol Autonomous Soviet Socialist Republic. One inch equals 172 miles. (*Based on map of Krasnoyarsk Krai, 1933, and other sources.*)

that its exploitation is retarded. The Yenesei (Fig. 1) is central Siberia's gateway to the Arctic, with a development intermediate to that of the Lena and Ob. From its source to the Ocean is 2,619 miles. If, instead, the distance be measured along the major tributary, the Angara, and its extensions beyond Lake Baikal, the Selenga and the Tola, the length is 3,553 miles. This places the Yenesei fourth among world rivers, or seventh in area of basin.

In American terms, the Yenesei is something like the Mackenzie. The southern limits of Siberia here parallel those of Canada so that the Yenesei valley is distinctly northern as well as mid-continental. Krasnoyarsk lies in the latitude of Edmonton. Four hundred miles south of the ocean is Igarka the new Arctic port with 15,000 people; its Canadian counterpart is Aklavik, a mere hamlet of a few hundred.

One hundred and four hours east of Moscow the Trans-Siberian Express comes to Krasnoyarsk, at the crossing of the Yenesei. Three centuries ago this was a Cossak outpost; today it is a booming city of nearly 200,000. Krasnoyarsk is the key to central Siberia. From here, four dozen river steamers ply north and south, and a fleet of aeroplanes, nearly as numerous, links the new developments in the Arctic with the railway. Much of the city is still an old Siberian village with log houses and muddy streets, but new pavement and scores of four and five story brick buildings record the achievements of the socialist regime.

For centuries, the Russians have wished that some Siberian river emptied into an ice-free ocean in order to free their Asiatic domain from its continentality. What geographers could not change and what the pre-revolutionary regime accepted as hopeless, the Soviets have set out to overcome. During the past decade Siberia has undergone greater changes than in any century since Yermak crossed the Urals in 1581.

In all the world, no pioneer expansion is more significant than that now under way in Soviet Siberia. The audacity of socialist planning and the tremendous resources actually under development give this new settlement program a distinctive geographic

interest. At the same time, it is well to remember that the Yenesei basin is no twentieth century Mississippi valley; nature here yields her gifts grudgingly, and human activities must always labor under climatic restrictions.

Across northern Asia, Russia's economic penetration is under the auspices of the Northern Sea Route Administration, which serves as a modern Hudson Bay Company in developing communications, resources, and settlement. The northern Yenesei is one of their principal areas of development.

Most of Yeneseiland lies within Krasnoyarsk Krai, one of the major divisions of the Russian Socialist Federation of Soviet Republics. The krai was created in 1934 by cutting up the former East Siberian Region, with Krasnoyarsk as the new capital. Within the krai are three subsidiary areas: the Khakass Autonomous Oblast in the south, the Evenki National Okrug in the northeast, and the Taimyr National Okrug in the far north. In keeping with the dynamic character of Soviet territorial schemes, these boundaries are subject to change as economic conditions develop.

Ninety-four per cent of the 1,800,000 people in the krai live in the agricultural area, south of the Angara River, where there is a density of 4.7 persons per square kilometer. This is comparable to other settled areas in Siberia. The entire krai covers 2,300,000 square kilometers, so that many areas in the north have a population of much less than one per square kilometer.

Lake Baikal, the upper Angara, and the Selenga River are within the East Siberian Oblast and the Buriat-Mongolian Autonomous Soviet Socialist Republic. Although tributary to the Yenesei, their economic interests are largely tied to the railroad rather than the river. Only passing attention is given to them here.

II. EXPLORATION AND SETTLEMENT

The steppes of the upper Yenesei have been inhabited since very early times. Thousands of kurgans or burial mounds testify to the long and extensive occupation of this area. These tumuli are of varying styles, usually low mounds a few yards across,

marked by several large unshaped stones. Much of this history has been reconstructed, and in the museum at Minusinsk there is a large display of successive cultures.

The earliest artifacts are paleolithic, and date from the close of the last glaciation. Later, about 2000 B.C., the area was occupied by hunters and cattle breeders. Three further stages, described by the Soviet regime as "tribal communism," developed prior to the rise of "feudalism" in the second century A.D. This state of "the enriching of local burgeoise with the corresponding growth of poverty of the working classes" continued until the Russian conquest in the seventeenth century which was "for the benefit of rich landowners and merchants" and the settlement of exiles and prisoners. The fifth and latest cultural change, as portrayed in the Minusinsk museum, is the arrival of Soviet Communism. Chinese bronzes and porcelains reached the Minusinsk basin as early as the seventh century B.C.

Mongoloid and Tungusic peoples form a minority in the area today. In the Khakass Autonomous Oblast it is reported that only some six per cent are natives, and the Minusinsk Basin is today dominantly Russian. Nomadism has disappeared from the steppes under the current program of collectivization. Descendants of the Mongoloid kurgan builders now live at the two ends of the Yenesei valley, both in the Sayan Mountains next to Mongolia and beyond the Arctic Circle. In each area they live in a tundra environment and keep reindeer. In the Taimyr National Okrug, 8,500 out of the total population of 12,000, belong to native tribes. Between these extremes of the valley, Russian influence has prevailed for three centuries.

Early Russian explorers reached the Yenesei at two points. The first were those who came through the Arctic to the lower part of the river late in the sixteenth century. A few years later Cossaks moving eastward across central Siberia reached the river and established Yeneseisk in 1618; Krasnoyarsk was founded ten years later.

At the close of the sixteenth century, the English and the Dutch were trying to find a passage around Asia to China. The Dutch explorer Barents reported that even then Russian fishing boats

made annual trips as far as the mouth of the Yenesei. The earliest recorded Russian visit to the Yenesei estuary was in 1610, and in subsequent years there were numerous merchants and tax collectors, all searching for furs.

As early as 1598 a trading expedition visited the Taz River, a tributary of the Ob, and pushed overland to the Yenesei. To protect this trade which consisted largely of furs, a fort was established on the Taz at Mangazey in 1601 and later at Old Turukhansk near the left bank of the Yenesei.

At this time, the Czar was engaged in the conquest of Siberia and feared that foreign powers might seize the north. In 1616 all navigation was prohibited in the Arctic, and even Russians were forbidden to use the seaways to the Ob and Yenesei. This meant the virtual end of settlement in the Arctic, although exploration continued overland.

The development of Siberia in the nineteenth century led to increased agitation for opening the sea route. During the sixties, the merchant Siderov spent 100,000 rubles in exploring the Arctic Ocean in order to bring out graphite from his mines at Kureika, but failed. Ten years later the voyages of Nordenskiöld inspired another merchant, Sibiryakov, to finance an attempt which was this time successful, and other trips followed. The building of the Trans-Siberian railroad stimulated further voyages and some of the rails were brought in by this route. In 1905, twenty-two boats pushed through to the mouth of the Yenesei with supplies for the war with Japan.

The overland conquest of Siberia dates from 1581, when the Cossak leader Yermak crossed the Urals. During the next fifty years the Russians spread eastward, easily conquering the nomadic tribes, and by 1632 established themselves on the Lena River at Yakutsk. Even before this overland expansion had reached the Yenesei, a few traders had come south from the Arctic as far as Krasnoyarsk, but did not establish permanent settlements.

The earliest outposts were forts and trading centers. The chief of these were Yeneseisk, founded in 1618, and Krasnoyarsk settled in 1628. Minusinsk was established in 1707 as a barrier

against the Mongols to the south, in opposition to whom the Russians were able to make little headway; instead, the pioneers followed the easier path of conquest eastward up the Angara.

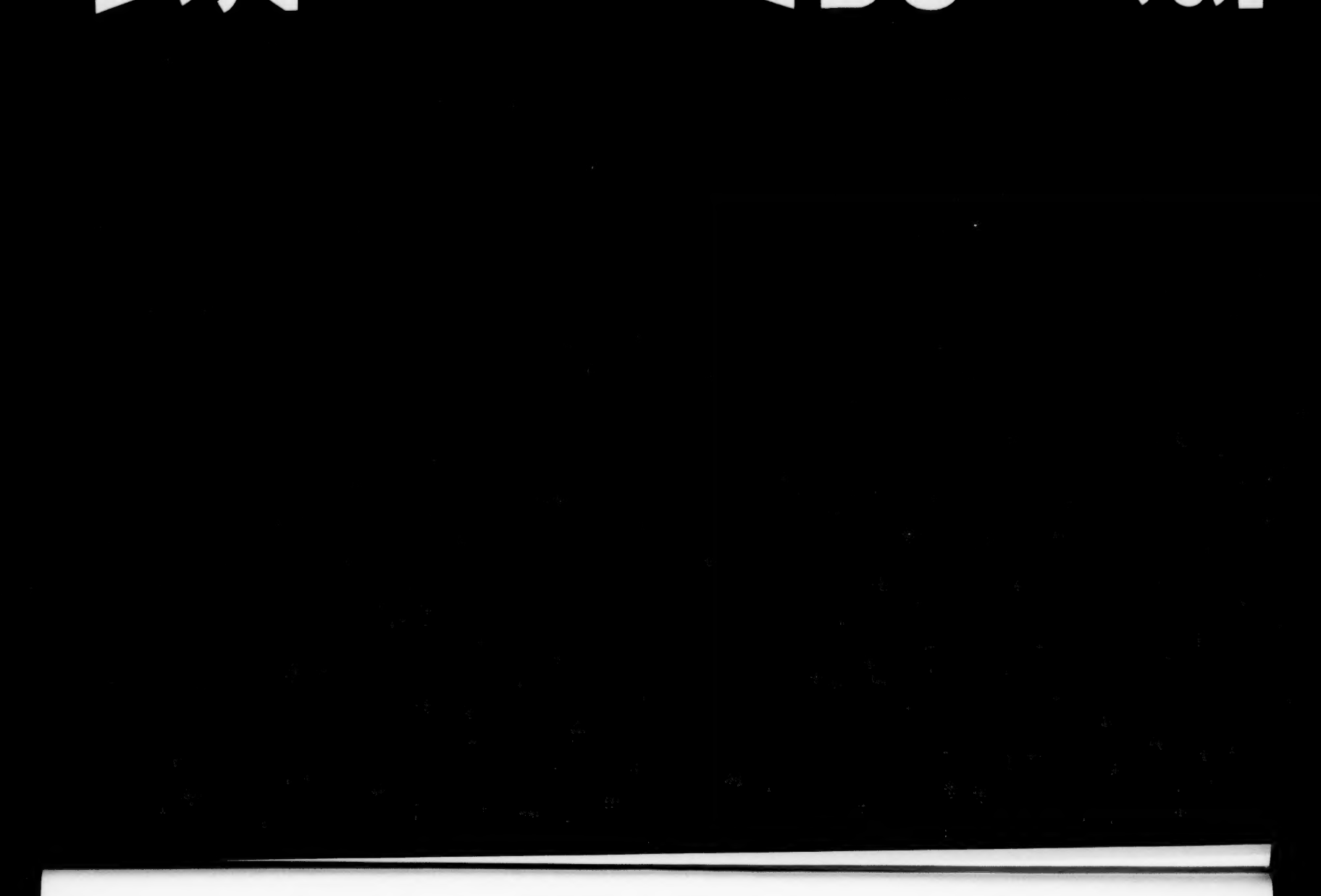
Meanwhile the Russian population of Siberia increased from 14,500 in 1632 to 70,000 in 1662, of whom about 7,400 were exiled prisoners. The native population at this time is also stated to be 70,000. Settlement along the Yenesei was not so attractive as farther west, and many of the newcomers were exiles. Between 1823 and 1832, 25,597 exiles were sent to the valley, some going as far north as Turukhansk. More recently, both Stalin and Lenin spent several years here, the former in the north and the latter in the south.

III. TRANSPORTATION BY LAND, WATER, AND AIR

Life in Yeneseiland is bound together by steamer, railway, cart, and plane. Across the valley near the 56th parallel, the Trans-Siberian Railway (Fig. 2) provides the main contact with the outside world. Here are the cities of Achinsk, Krasnoyarsk, Kansk, Taishet, Irkutsk, and Ulan Ude, formerly Verkhni Udinsk; each of them focal points for the narrow wedge of agricultural land astride the railway. Here as elsewhere the railway is double tracked, and the second bridge across the Yenesei was finished in 1937. The daily express and five other passenger trains in each direction are always full, and at any time of day or night one may find crowds of people waiting in the stations. Freight traffic usually amounts to two dozen trains a day each way.

One branch railway connects Achinsk with Abakan, across the river from Minusinsk. Through trains from Krasnoyarsk to Abakan make the trip in 18 hours, as against three days by boat. During the Third Five Year Plan it is proposed to extend the line northward to Yeneseisk.

Navigation on the Yenesei extends from Dickson Island in the Kara Sea to the Oznachena rapids at the edge of the Sayan Mountains, 1852 miles to the south. Above these rapids the river is again navigable for 180 miles into the Tanna Tuvan Republic. A total of 47 boats operate on the river; about a dozen of them provide proper passenger accommodations, (Fig. 3)



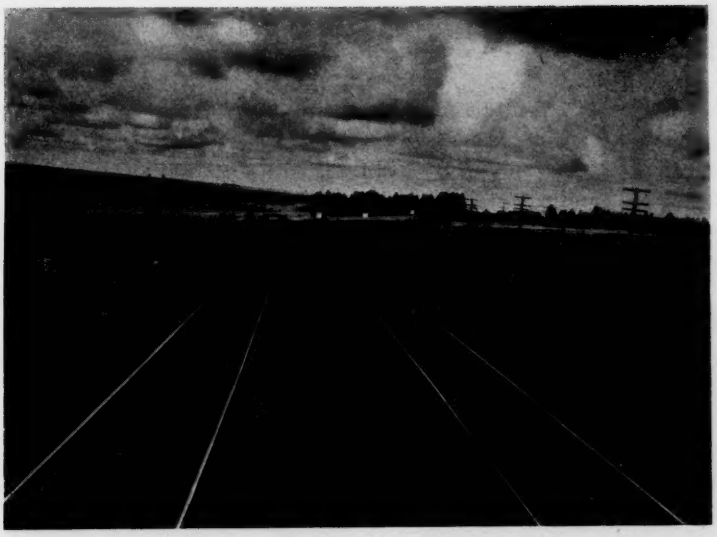


FIG. 2. The Trans-Siberian Railroad in the agricultural zone west of Krasnoyarsk. This double-tracked line provides daily access to Europe and the Pacific. (*All photographs are by the author, unless otherwise credited.*)

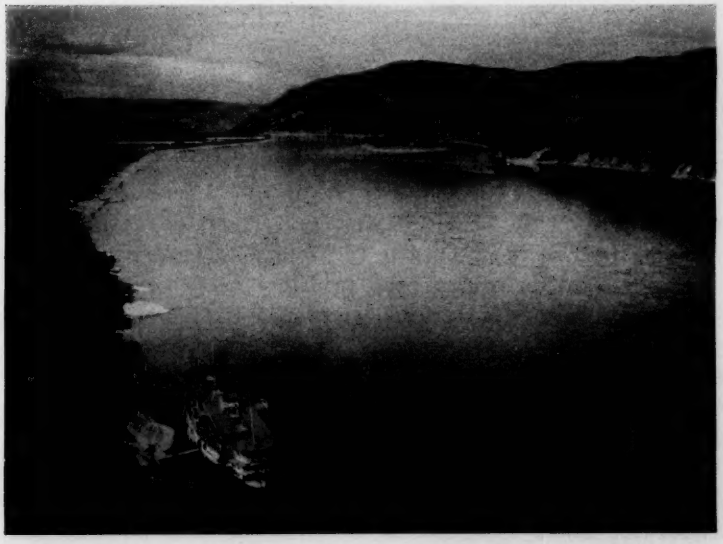


FIG. 3. The Yenesei River and the steamer "Kassior" in the midst of the Eastern Sayan Mountains, south of Krasnoyarsk. 1852 miles of navigable waterways give unity to Yeneseiland.

while the others are freight boats or tugs. Sand bars in the estuary near Ust Port limit the draft of ocean vessels to 23 feet. Steamers up to 7,000 tons regularly come to Igarka, 400 miles upstream, and could almost reach the mouth of the Angara. In the central and upper portions the current is swift, averaging 7 miles per hour at Krasnoyarsk.

Owing to the long winter, the navigation period at Krasnoyarsk is but six months, from May until November. At Igarka the ice does not leave the river until early in June. Ocean vessels are limited to a little over two months, from the end of July to the beginning of October, on account of ice in the Kara Sea.

The tributaries of the Yenesei are little used, except for rafting timber. Small vessels occasionally go up the Angara almost to Irkutsk, but several rapids make the passage difficult. Beyond Lake Baikal there is regular service on the Selenga from Ulan Ude to Kyakhta near the Mongolian border. On the Nizhni Tunguska irregular launch service reaches Tura, capital of the Evenki National District, 500 miles to the east.

The navigable length of the Yenesei system, including the tributaries of Lake Baikal is 5,886 miles, while logs may be rafted over a distance of 7,104 miles. Scheduled service is limited to the Yeneseisk-Krasnoyarsk-Minusinsk line and to the Krasnoyarsk-Igarka line with occasional extension to Dudinka. From the railway north to Igarka normally requires eight days; upstream the trip takes ten to twelve days. There are also regular sailings on the Selenga River from Ulan Ude on the Trans-Siberian Railway south nearly to Mongolian border.

Unpaved roads connect the principal settlements south of Yeneseisk, and in winter sleds travel over the frozen rivers. In the steppes it is possible to drive autos almost anywhere across the open country. There are three important gravelled highways. One leads north from Krasnoyarsk to Yeneseisk, with regular autobus service which covers the 175 miles in two days. With increasing difficulty one may continue by cart to Turukhansk. Parallel with the Trans Siberian railway is a main highway, known as the Great Siberian Track. An important branch road leads south from Achinsk to Minusinsk and Tanna

Tuva. Beyond Minusinsk this road, well gravelled, is known as the Usinsky Track and forms one of the gateways to Mongolia.

The Yenesei valley is one of the principal air-ways to the Arctic, and the Northern Sea Route Administration has a large fleet of planes in service. In 1937 this included two dozen or more Soviet-built hydroplanes (Fig. 4) capable of carrying a ton of freight or ten passengers, several old German two-motor ships, a fifteen passenger Sikorsky, and two thirty-two passenger

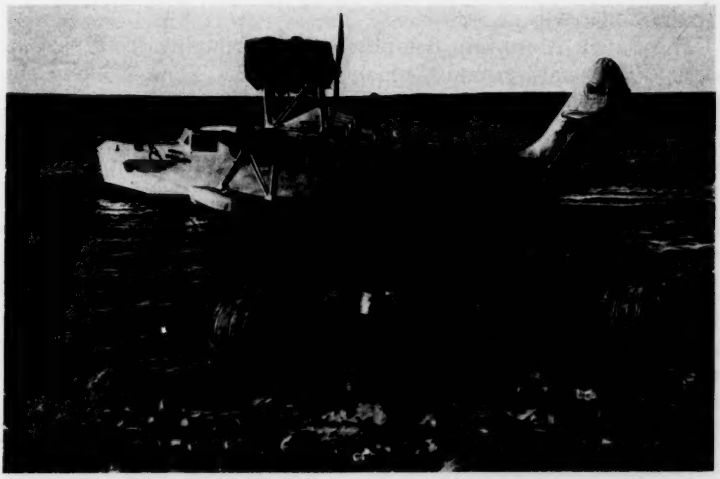


FIG. 4. Soviet built hydroplane on the lower Yenesei. The development of the Arctic has been made possible by modern transport. (*Courtesy Northern Sea Route Administration.*)

Douglas planes. During the open season these land on the water; after the river freezes the planes are equipped with skis.

Whenever the weather permits, daily flights are made from Krasnoyarsk to Igarka. The Douglases fly non-stop in ten hours; the smaller planes usually stop at Yeneseisk, Verkhni Imbatsk, Podkamena Tuguska, and Turukhansk and take more than a day. Beyond Igarka there is frequent service to Dudinka, and from there with less regularity planes fly eastward to Norilsk, Khatanga and Nordvyk, and north to Dickson Island. Un-

fortunately flying conditions in the north are often poor. Numerous radio and meteorological stations aid navigation.

IV. THE SAYAN MOUNTAINS

The headwaters of the Yenesei lie entirely within the basin of Tanna Tuva, formerly an isolated part of Outer Mongolia known as Uriankhai, but now a Soviet republic, under the protection of the U. S. S. R. Between this mountain-surrounded lowland and the Soviet Union lies the Western Sayan range, pierced only by the Yenesei.

The Sayan Mountain complex extends roughly from east to west. The southern spur which crosses the Yenesei along the border with a southwesterly trend is known as the Western Sayan. Another spur farther north which does not continue to the west is called the Eastern Sayan. Both parts are made up of lower Paleozoic formations much folded and cut by numerous granitic intrusions. Topographic surveys are lacking but many elevations run from one to two miles.

Recent meteorological observations in the Sayans show that the precipitation is very uneven, but in general is considerably greater than would be expected for a continental interior. In most cases the mountains have higher figures than nearby lowlands.

In the Eastern Sayans there are a number of meteorological stations in valleys, all reporting less than 400 millimeters. Even stations at elevations of around 1,300 meters have but 258 and 284 millimeters. In the Western Sayans observations have been made at the Arden pass on the Usinsky highway to Tanna Tuva. At the Olenya Creek station on the north slope, altitude 1,475 meters, the six year average is 1,197 millimeters, or 47 inches. On the south slope shorter periods give the following results: 1,365 meters—993 millimeters; 1,265 meters—989 millimeters; 1,125 meters—898 millimeters. The corresponding figure for Minusinsk is 323 millimeters. Apparently this moisture has come overland 4,000 miles from the Atlantic through the gap between the Alps and Scandinavia. Late July is the rainiest

period, with a minimum in February and March. In some years at Olenya there was not a day of snowfall during February.

Temperature and rainfall are closely correlated with relief so that summer and winter are matters of altitude more than of latitude. Yermakovsk lies at the northern foot of the Western Sayans; 880 kilometers to the north is the Vorogov valley. The difference in latitude prolongs the frost-free season at Yermakovsk by 37 days. Eighty kilometers from Yermakovsk at an elevation of 1,475 kilometers is the mountain station of Olenya, where the warm season is identical with that of Vorogov, namely 159 days. In other words, to shorten the summer by one day, it is necessary to travel 24 kilometers along the meridian or to ascent vertically but 38 meters; a difference of 1 to 630. The temperature gradient between Olenya station and Yermakovsk in winter is 0.3°C. per 100 meters, and 0.66°C. in summer. During calm periods in the winter strong inversions may occur.

The highest parts of the Sayans, at elevations of 3,500 meters, have permanent snow fields and small glaciers. There is no proper summer while in the Minusinsk basin, 3,000 meters lower, the frost-free period is 200 days. This is a difference of about 6.5 days change in the duration of frostless weather for each 100 meters of elevation. In comparison, the length of the summer at the mouth of the Yenesei is about 110 days, so that 100 meters vertical change is equal to a movement of about 90 kilometers to the north. The Sayan mountain tops have the lowest annual average temperature of the entire Yenesei valley.

Pleistocene glaciers are reported to have occupied all valleys in the Sayans above 1,300–1,400 meters elevation, with moraines descending to 450 meters. Pronounced ampitheatres and enlarged valley heads down to elevations of 775 meters (Mount Saibar, Fig. 5) suggest local nivation cirques and snow pockets. These periglacial phenomena are best developed on protected north and east exposures.

During its passage through the Western Sayans, the Yenesei falls 212 meters. It is proposed to construct two huge dams for

hydroelectric power and to regulate the flow, which reaches a maximum of 2,700 cubic meters per second in summer and a minimum of 125 in winter.

The vegetation and soils of the Sayans reflect the wide climatic contrasts of these ranges. On their slopes are repeated each of the vegetation zones which may be found to the north. Tundra, taiga, steppe and farm land are all represented. Beyond the

FIG. 5. Mt. Saibar, elevation 775 meters, in the Minusinsk Basin. The enlarged valley heads may represent incipient glaciation. Trees are confined to the protected north slopes.

tree line is a tundra flora approximating that of the Arctic. Trees are rare above 2,500 meters and the vegetation is of two sorts, damp meadows with alpine flora (*dryas astopetalia*) and a thin semi-peat horizon or a moss and lichen cover with cedar bush (*pinus pumila*).

Within the taiga or forest zone is a well developed podsol soil with a humus layer not exceeding 10 centimeters underlain by a loose yellowish sandy horizon. On the lower wooded slopes

are forests of pine and larch. Higher up are splendid stands of cedar and silver fir, with the latter in spots replaced by larch. Near the upper limits are *caragana jubata* and *rhododendron fragrans.*

The forest zone of the Sayans has both an upper and lower limit. The lower tree line is as sharply marked because of drought as is the upper because of cold. In many localities one may look across the foothills and see the boundary between steppe and forest limited by contours which clearly betray the isohytes. This lower limit is not a continuous line, for the effect of exposure is marked. North and east slopes are wooded while sunny slopes are bare; it is the uniform presence of a lower limit which is so striking.

The population of these southern mountains is scanty. With the expansion of agriculture in the Minusinsk basin, large scale tractor cultivation is invading the lower valleys, but the majority of the people are pastoralists. Cattle, sheep and horses are grazed on the upper steppe lands by nomads who move up and down the slopes with the seasons. A few wandering Tungusic tribes keep reindeer in the upper forest zones. During the winter there is an influx of trappers and woodsmen.

Near the larger streams timber is cut for shipment to Krasnoyarsk. The separate logs are floated to the Yenesei where they are assembled into large rafts. Downstream from the mouth of each tributary a curving boom projects a third of the way across the channel from the right hand bank to collect the separate logs. In these northern latitudes the effect of the earth's rotation is such that driftwood all hugs the eastern bank.

V. THE MINUSINSK LOWLANDS

The Minusinsk Basin is three fold (Fig. 6). Between the gorges of the Western Sayan and Krasnoyarsk, the Yenesei flows through three rolling lowlands, each floored with Devonian and Carboniferous strata. Between these areas of horizontal rocks are the folded, intruded and metamorphosed extensions of the Eastern Sayans and the Kuznetz Alatau on the west. These

two ranges, each rising to upwards of a mile, form the eastern and western limits of the Yenesei valley south of the Trans-Siberian railway. Plains and hills alternate.

Beneath each of the basins are important beds of coal, with the best deposits near Abakan. One mine is producing coal at Chernogorsk north of the former city. There is an aggregate

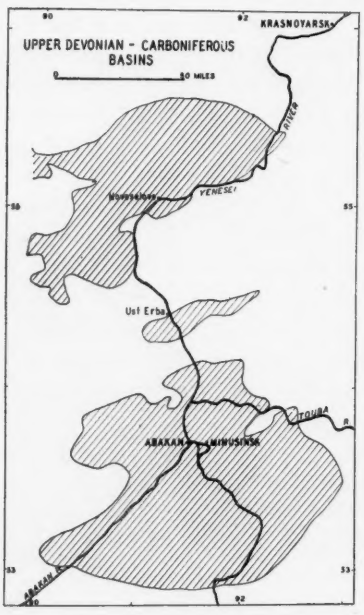


FIG. 6. The Minusinsk Basin is three-fold. Between the Western Sayan in the south and the Eastern Sayan near Krasnoyarsk are three lowlands floored with upper Devonian and Carboniferous formations, in part coal-bearing. (*Data from XVII International Geological Congress.*)

thickness of forty meters in seams of one meter or more, and the total reserves were reported to the XVII International Geological Congress in 1937 as 20,612,000 tons.

Surrounding the coal basins are numerous mineral deposits, none of which are well developed. Some copper was produced before the Revolution. Alluvial gold is nearly worked out, but

lode mining continues. Lead, zinc, mercury, molybdenum, iron, asbestos, and barite are known. During dry years salt and mirabilite are extracted from some of the steppe lakes.

From its headwaters as far north as the Podkamena Tunguska, the Yenesei is bordered by a series of unusually well developed terraces. Five levels are distinctly marked, and some writers define as many as eleven. The terraces are best developed in the vicinity of Krasnoyarsk and may clearly be traced south of Minusinsk. The uppermost and most extensive is the Torgashinsky terrace, about 70 meters above the present river and probably Upper Pliocene in age.

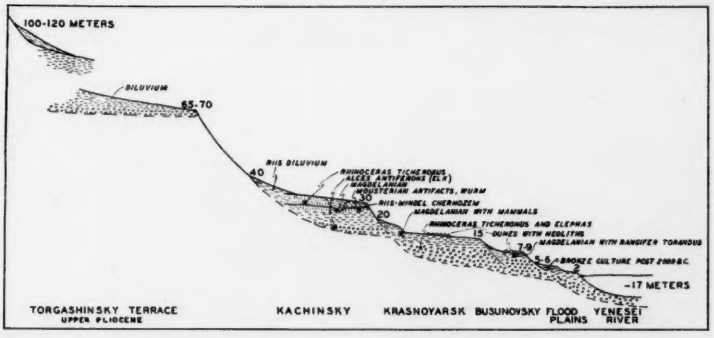


FIG. 7. The southern part of the Yenesei is bordered by a series of remarkable terraces, here shown near Krasnoyarsk. (*After V. Gromov.*)

The lower terraces have the best dated fossil evidence (Fig. 7). Human artifacts are found as high as the third and occasionally in the fourth level. The first terrace, which is the present high flood plain, contains bronze implements and is later than 2,000 B. C.; the second and third have numerous neolithic sites; and there is Magdelanian and some Mousterian material in the fourth. The human occupation of the Yenesei thus dates back at least to the Riis-Wurm interglacial epoch. Soviet geomorphologists have given little attention to the origin of these terraces so that their genesis is obscure. Regional diastrophism rather than Sayan glaciation is said to be the origin.

The present channel of the Yenesei through the lowlands is braided, with numerous sand bars (Fig. 8). The depth everywhere exceeds six feet, and is commonly several times that figure. Dredging is necessary for navigation in only a few localities. Through the basin, the Yenesei falls from an elevation of 240.3 meters at Minusinsk to 133 meters at Krasnoyarsk, with a slope of 0.25 meters per kilometer. The current is remarkably swift,

FIG. 8. The village of Novoselovo, with its swing ferry, is one of many collecting and distributing centers along the river. The well developed terrace on the opposite bank is the Torgashinsky level. (*Courtesy George W. Bain.*)

in most places at least ten miles per hour. A few miles south of Krasnoyarsk, the Third Five Year Plan calls for a dam 950 meters long and 62 meters high to generate 1,350,000 kilowatts of electricity.

Another of the unsolved problems of the Minusinsk Basin is the presence of hundreds of undrained depressions, usually occupied by salt lakes, from a hundred yards to a mile or more in dimensions (Fig. 9). The lowest point in the rim of these basins is usually some tens of feet above the water surface, and

the side slopes occasionally exceed ten degrees. They are developed in all types of rock, and are apparently unrelated either to faulting or to old drainage lines. The probable explanation is that they are deflation hollows, excavated by the wind during a drier period.

The Minusinsk steppes have the longest growing period of any area in eastern Siberia, with approximately 200 days free from

FIG. 9. Numerous enclosed basins contain salt lakes of fluctuating size. Near Shira. (*Courtesy George W. Bain.*)

frosts. Only three months, however, have an average over 10°C. Mid-summer temperatures are not noticeably warmer than those well to the north, but the length of the season decreases rapidly as one leaves the lowlands. During the winter, cold air collects in the basins and a minimum of −53.7°C. has been recorded near Minusinsk. This appears to be the lowest temperature ever recorded anywhere in the Yenesei valley. The 21-year average for July is 20.4°C. and for January −20.5°C.

Eighty per cent of the precipitation comes as rain, and the remainder of the 323 millimeters falls as snow. The winter of

1936–7 had the heaviest snowfall ever recorded and as a result the salt lakes were high, the spring floods on the Yenesei in 1937 broke all records, and crops were unusually bountiful. Winds from the west predominate, but have lost most of their moisture in crossing the Kuznetz Alatau range. Thus altitude within the basin is important, with the lowest parts of the valley the most arid.

Most of the basin is a cold steppe, classified by Koeppen symbols as DBSb. Occasional park-like groves of trees dot the hills. The dominant soil types are chestnut brown soils and chernozems, but vertical zoning is so important that all types from saline solonchaks to podsols are present in nearby areas. The chestnut soils have an A horizon with humus to 20 centimeters, and a B horizon with lime and concretions below 18 to 30 centimeters. The chernozems provide very rich soils, with 6 to 24 per cent humus.

These rolling steppe hills are primarily grazing country, with flocks of cattle, sheep and horses. Nomadism (Fig. 10) has practically disappeared since 1930, and collective cattle farms are now the rule. When visited in 1937 the number of animals appeared to be much below the carrying capacity of the land, but the grass of that season was unusually good. Considerable amounts of hay are cut in the better years (Fig. 11).

The impact of the Soviet regime is most noticeable in the extension of crop land. Large areas never before plowed are now being cultivated by tractors (Fig. 12, 13) and horse drawn plows. Machines are operated easily because of the practical absence of gullies or ravines. In years of abundant precipitation the virgin soils yield exceptional harvests, but the average rainfall is probably inadequate for dependable agriculture. Signs are already apparent that severe wind erosion may follow the breaking of the sod. Wheat and oats are the chief crops. An agricultural experiment station near Minusinsk is endeavoring to develop apples, berries, and other fruits, with partial success.

The city of Minusinsk has a population of 25,000, second largest along the Yenesei. Like most Siberian towns it has the appearance of an overgrown village of log houses with relatively

FIG. 10. The steppes of the Minusinsk Basin are the traditional home of the Khakass nomads, a mixture of Mongoloid and Tungusic peoples.

FIG. 11. Herds of cattle, sheep, and horses graze on the rolling steppe. In years of abundant rainfall, the natural grasses are cut for hay.

FIG. 12. Machine tractor stations provide mechanized equipment for the transformation of natural grasslands into cultivated fields.

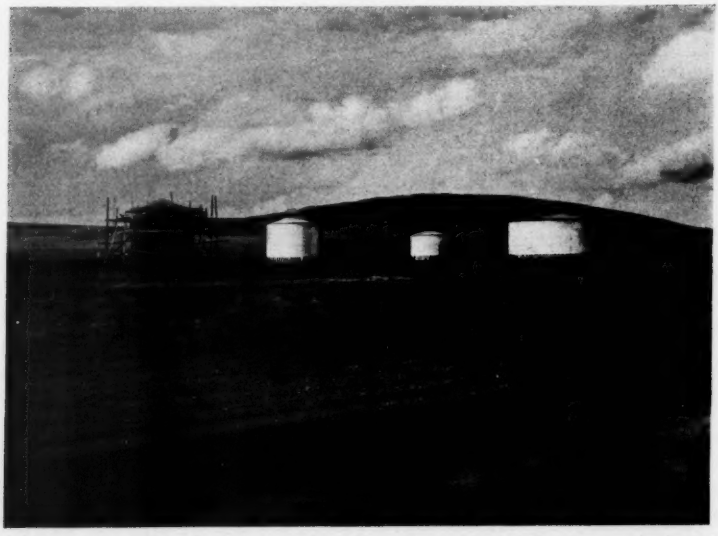


FIG. 13. Gasolene tanks along the Yenesei supply fuel for the agricultural exploitation of southern Siberia.

few urban functions. The only other large settlement in the basin is Abakan, at the end of the railroad near the mouth of the Abakan River. Elsewhere there are widely spaced villages with a hundred one-story log houses at the most (Fig. 14). Isolated farmsteads are rare. In several parts of the lowlands one may travel for tens of miles without seeing a settlement. Most roads are mere trails, and the rolling topography makes it possible to drive a car across country almost at will.

FIG. 14. Like most agricultural villages, this settlement south of Minusinsk has but a single street. Behind each of the unpainted log houses is the vegetable garden for the farmer's personal needs.

This is an agricultural frontier. No statistics are available of increased acreage or added population, but hundreds of square miles are being changed from pasture to crop land. It is an impressive sight to see great fields plowed for their first harvest in history. Clusters of oil tanks along the river reflect the increasing importance of the tractor in opening this new land. The Soviet Union has so many partially developed farms within already settled areas to the west that efforts to increase crop

production are primarily directed at more efficient agriculture in the older areas rather than toward increased acreage in this new land. Nevertheless the Minusinsk Basin is a lodestone for new colonists (Figs. 15, 16). In common with other areas in Siberia, this is part of the last great pioneering land in the world outside the tropics.

FIG. 15. Pioneer farm land in the vicinity of Mt. Saibar. The lighter fields are harvested crops; the black patches represent recently plowed chernozem soil. (*Courtesy George W. Bain.*)

VI. THE CENTRAL AGRICULTURAL REGION

The good land of the U.S.S.R. forms a thin ragged triangle extending eastward from the European frontier into Asia. Within lines drawn from Leningrad and the Black Sea eastward to Lake Baikal lies most of the agricultural area of the country (Fig. 17). To the north are the boreal forests, to the south are the steppes. On the one side agricultural expansion is limited by cold, on the other by drought. Much of the history of Russia has consisted in driving the agricultural wedge eastward between the forest and the steppe, and thus, at the same

time, moving north and south. The Trans-Siberian Railway bisects this fertile triangle, crossing the Yenesei at Krasnoyarsk.

The presence of this strip of cultivated land combines with the facilities of the railway to impose an east-west economic regionalism on the otherwise northward trend of the Yenesei valley. Elsewhere most settlement nuclei are located in the main valley of the river; here they extend to either side along the railway zone with local clusters about each station. This

FIG. 16. (Continuation of Fig. 15.) Under the second Five Year Plan, thousands of acres of rich grassland have been plowed for the first time in history. This is part of the world's last great agricultural frontier. (*Courtesy George W. Bain.*)

eastward tendency continues beyond Lake Baikal to the limits of the Yenesei drainage area east of Ulan Ude, but with lessened agricultural possibilities. Irkutsk and the Baikal area constitute a separate geographic sub-region.

Fertile chernozem soils and 16 inches of rainfall make this an area of fairly successful agriculture (Fig. 18). By no means all of the land is under cultivation, for large fields alternate with wooded steppe. The southern limit of the Central Agricultural

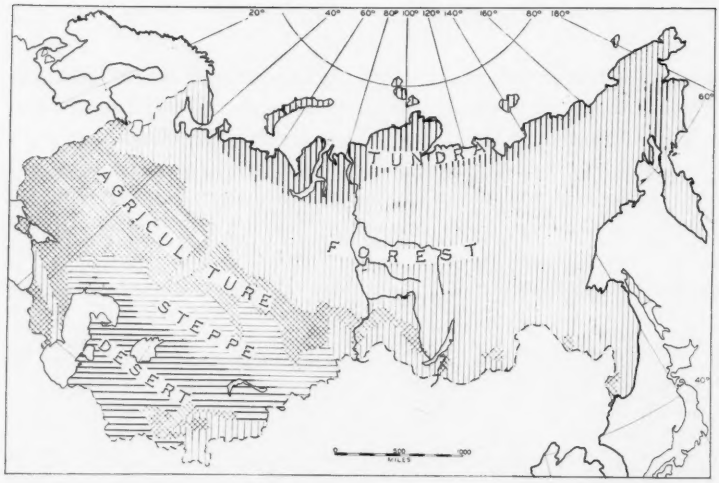


FIG. 17. Agricultural Russia is a wedge of good land between two regions of cold to the north: the forest and the tundra, and two regions of drought in the south: the steppe and the desert. The Yenesei River cuts across these zones in the center of the U.S.S.R. (*Data from the Great Soviet World Atlas.*)

FIG. 18. Harvesting on the Yenesei flood plains, south of Krasnoyarsk. Tractors and modern harvesters are rapidly replacing horse-drawn equipment.

Region is the Sayan folded land, while the northern limit is the taiga, into which agriculture has made but sporadic forays. To the east cultivation is restricted by the Trans-Baikal mountains, while westward agricultural activity merges with that of the Ob Basin. Wheat and oats are dominant.

Summer temperatures differ but little throughout the length of the Yenesei valley. It is in winter that the most pronounced contrasts occur, both in latitude and with altitude. Due to the open and level character of the Central Agricultural Region, cold air does not stagnate during the winter so that temperatures do not go as low as in nearby mountain basins. This lessens the annual range. Summer conditions prevail only during June, July and August. The precipitation maximum is in July, and winters are dry. In terms of Koeppen's classification, most of this region is termed DBSc, a cold steppe where less than three months have a monthly average over 10°C.

Temperatures, in centigrade, are given in the following table:

PLACE OF OBSERVATION	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	YEARLY AVERAGE
Krasnoyarsk	−18.1	−15.1	−8	1.6	9.7	16.9	20.0	16.7	10.0	1.3	−8.8	−15.8	0.9
Verkhni Imbatsk	−23.6	−27.9	−13.6	−5.5	1.9	11.6	17.5	13.3	6.8	−4.4	−16.2	−24.8	−5.0
Turukhansk	−25.4	−25.7	−17	−8.8	−0.3	9.8	16.8	13.1	6.4	−6.7	−19.5	−27.3	−7.1
Dudinka	−28.5	−26.7	−23.5	−15.8	−5.7	5.1	13.2	11.5	3.7	−8.6	−20.6	−26.8	−10.1
Golchikha	−31.4	−26.1	−22.3	−16.5	−7.8	6.6	13.3	10.2	4.8	−7.8	−22.8	−23.8	−10.3
Dickson Island	−28.3	−29.5	−26.9	−16.5	−8.0	−0.1	4.7	5.3	0.4	−9.1	−20.9	−23.3	−12.7

The Central Agricultural Region is not an open grassland, but rather a transitional park land, with alternating grassy steppe and forest. The latter is both coniferous and deciduous. Soils are typically chernozems, high in humus and with a zone of lime concretions at a depth of 60 centimeters. The parent material is often loessial. Considerable areas are underlain by leached chernozems, deprived of their lime and in various degrees passing into podsol chernozems.

Krasnoyarsk (Fig. 19) dominates the Yenesei Basin economically and politically. It is by far the largest city on the river, and its position at the crossing of the Trans-Siberian Railway

gives it particular significance. Although Krasnoyarsk is by no means the most important of Siberian cities, few others have as strategic a location (Fig. 20). All travel from east to west must pass through this corridor; there is no other practical route to Vladivostok. Immediately to the southeast are the Sayan highlands; northeast the Yenesei ridge or horst with elevations of 3,000 feet imposes another topographic barrier. Other Siberian cities lie at river-rail junctions, but none of them have the same

FIG. 19. Looking eastward over Krasnoyarsk and the Yenesei. New four- and five-story buildings rise above the old one-story log cabins in this city of 200,000 people.

dominating position with respect to east-west travel. Krasnoyarsk has become the crossroads of central Siberia because it commands the only feasible crossing of the Yenesei.

The city dates from 1628 when a fortress was built on the west bank by the Ataman Dubinsky under orders from the first of the Romanoffs. The population grew slowly, and even in 1897 numbered but 26,699, of whom only 245 were voters. By 1926 the population had risen to 72,100 and by 1933 to 101,500, while the census of 1939 reported 189,999.

The center of the city lies on the third terrace, some 50 feet above normal water level. Wharves and landing stages line the water front, with a rectangular street pattern to the base of a high hill half a mile to the west. Residential (Figs. 21, 22) and special areas extend north and south along the river and westward along the railway, as well as on the east bank. Most shops are along either the old main street, leading north from the station, or along the new main street parallel to it.

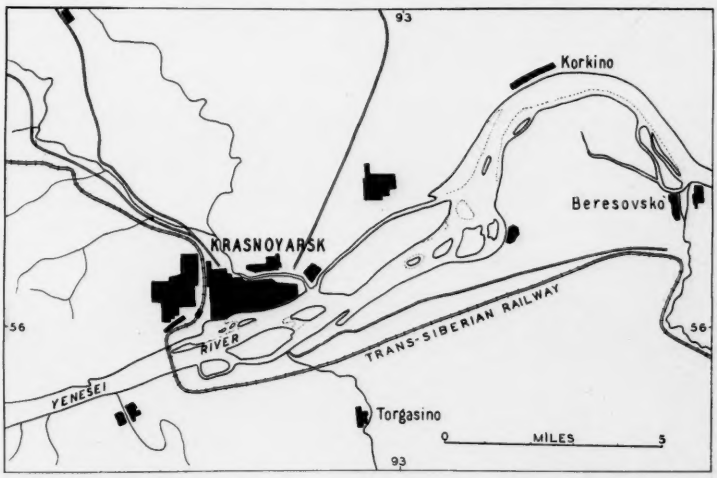


FIG. 20. Krasnoyarsk commands the only practical crossing of the Yenesei between the Sayans and the Yenesei horst. Most of the city lies on the high western bank, but new suburbs, not shown, are developing to the east of the river.

Despite the rapid growth of recent years, the material evidence of socialist construction is noticeably less apparent than in cities farther west. There are several dozen modern four or five story brick structures, but most of the city is made up of old one and two-story unpainted log houses. Most streets are muddy, and the principal business thoroughfares were not paved with cobblestones until 1937.

Because of its location, Krasnoyarsk has always been a significant railway point, with large repair shops. Prior to the Revolution there was little other industry and only 700 workers

FIG. 21. The house of a former merchant in Krasnoyarsk, one of the best pre-revolutionary residences.

FIG. 22. A characteristically muddy street in the residential section of Krasnoyarsk. Dwellings are almost everywhere of unpainted wood.

were employed outside the railway yards. At present there is a large car building works with a capacity of 10,000 freight cars annually, a flour mill with a capacity of 700 tons per day (Fig. 23), a factory making gold-dredging machinery, a paper and pulp plant, a pencil factory which uses Yenesei graphite, a cement works, and a large central thermal-electric plant. Several of these new plants are on the eastern bank across from the old city. There are no street cars, and only a few busses. About

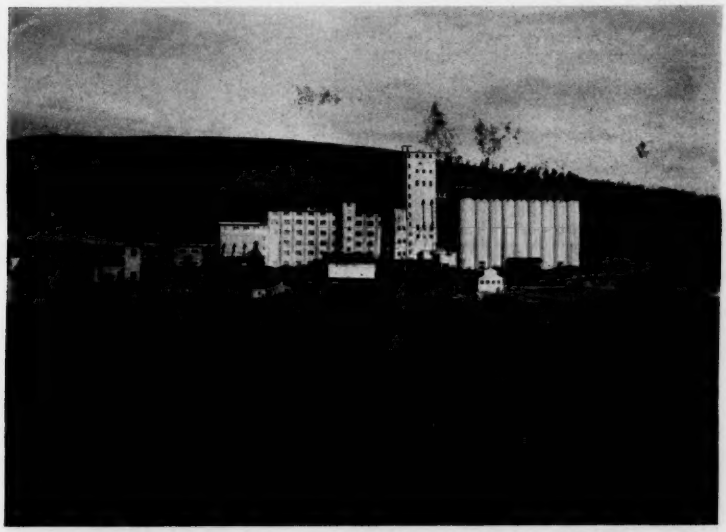


FIG. 23. New grain elevator and flour mill along the Yenesei at Krasnoyarsk.

three dozen automobiles supplement the dilapidated droskies. The full tide of industrialization will not reach the area until the close of the Third Five Year Plan in the early 1940's.

The two railroad bridges are the only structures which cross the Yenesei throughout its length. There is no roadway for vehicles, which must use the ferry boats.

Much of the significance of Krasnoyarsk is related to its larger setting rather than to its immediate site. Since the establishment of Krasnoyarsk Krai in 1934, the city has been

an important political center. Here, too, are the local headquarters of the Northern Sea Route Administration, which is actively developing the Arctic. There is an important military aviation base on the east bank of the river.

Krasnoyarsk has the usual public market (Fig. 24) with extensive stalls for assorted merchandise and facilities for farmers to bring in their vegetables, chickens and other produce. Prac-

FIG. 24. Krasnoyarsk has a large public market where farmers bring produce from the collective farms or surplus crops from their own garden plots.

tically all agriculture in the vicinity is carried on in collective or state farms, but each farmer still has his own garden plot from which he may sell any surplus. There is a large and well kept "Park of Culture and Rest". In common with most Siberian cities, the commercial area seems disproportionately small for the population, scarcely larger than for an American city of 25,000. There are several well stocked small stores, but

even food stores are surprisingly limited. The absence of retail food shops is partly related to the fact that many large apartments have central kitchens which secure their supplies from wholesale sources.

The purchasing power of most people is rather low, although definitely going up. Prices of manufactured articles are about the same as in Moscow, but are very high according to European standards. Since rents are never over one-tenth of one's income, and the government cares for hospitalization and old age insurance, incomes may be spent for current needs. As an example, I visited an aviator whose monthly salary was 800 rubles, plus another 800 rubles for Arctic flying, plus a mileage bonus. His wife also worked, so that their combined income was around 2,500 rubles a month (five rubles nominally equal one dollar). They lived in a one room apartment for which they paid 20 rubles a month.

The oldest settlement in the Central Agricultural Region is Yeneseisk, founded in 1618, 30 miles above the mouth of the Angara and near the Kozachensky Rapids. During the eighteenth century it was one of the stations on the tea route from China. With the building of the railway late in the nineteenth century, the town lost much of its importance, and has remained a sprawling village. During the Third Five Year Plan it is proposed to build a railway from Yeneseisk to the Trans-Siberian at Achinsk which will open up new agricultural land and timber reserves. Yeneseisk is in the taiga near the northward limit of the forested steppe; at the same time it marks the present limit of extensive agriculture.

Climatic conditions in the immediate neighborhood of the Yenesei are moderated by the importation of warm water by the northward flowing river. Whereas the mean annual air temperature at Yeneseisk is −1.5°C., the mean annual water temperature is 5.9°C. At Dudinka, beyond the Arctic Circle, air temperatures average −10.5°C., while the river has a mean annual temperature of 4.3°C. Cultivated fields near the stream thus enjoy a tempered climate.

The first steamboat appeared on the Yenesei in 1865, operating

from Golchika near the mouth to Yeneseisk, and since 1881 steamers have gone above the Kozachensky Rapids.

The Yenesei River at Krasnoyarsk is ice-free less than 200 days a year, from the beginning of May to the middle of November. The practical length of the navigation period is commonly stated as 185 days. The depth is almost everywhere adequate for river steamers (Fig. 25), although as the river leaves the Sayan

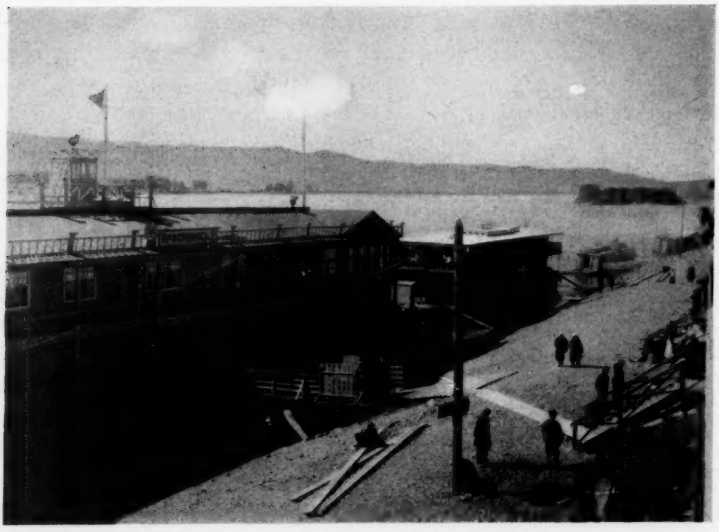


FIG. 25. One of several landing stages at Krasnoyarsk, with the Eastern Sayans in the background.

highlands, in the vicinity of Krasnoyarsk, there are numerous sand bars. Swing ferries and launches provide access to the opposite shores. Steamers up to 225 feet in length with 8 foot draft regularly operate on the Yeneseisk-Krasnoyarsk-Minusinsk run, and also from Krasnoyarsk to Igarka. The former trip requires a week for the round trip, the latter eighteen days or more.

The river elevation at Krasnoyarsk (Fig. 26) is 133 meters and at Yeneseisk 65 meters, giving a fall of 6 meters per kilometer.

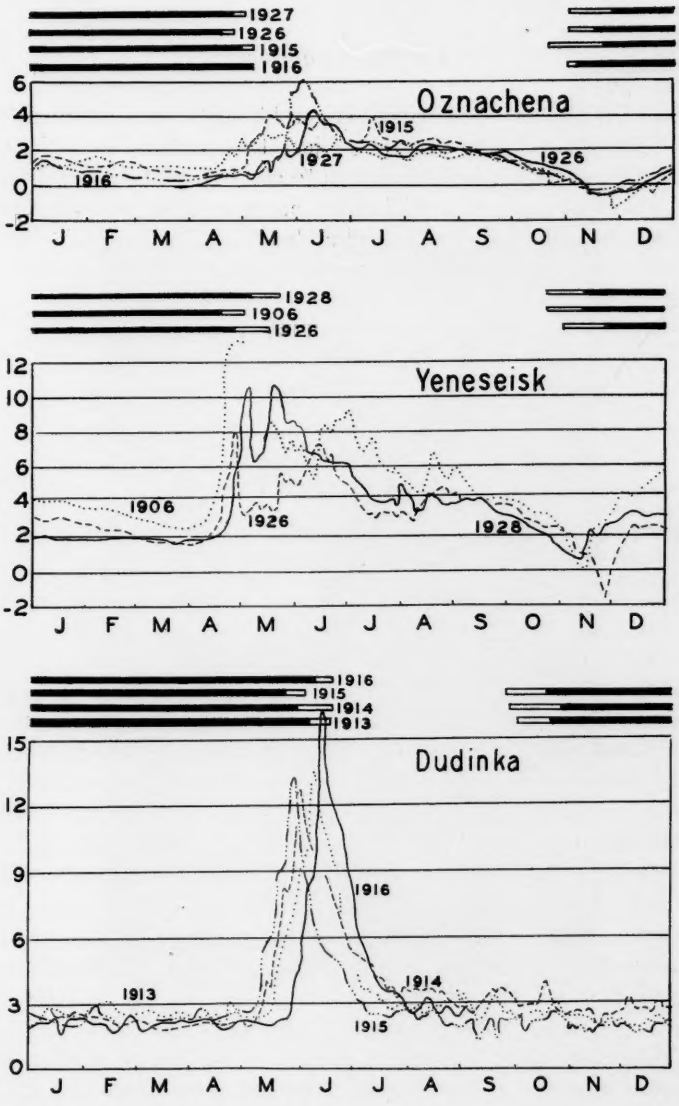


FIG. 26. River levels and ice periods at Oznachena near the southern frontier, Yeneseisk below the junction of the Angara, and Dudinka near the mouth. The solid bar indicates the continuously frozen time and the open bar the period of partial freezing. The high water stage accompanies the spring thaw. Elevations in meters. (*Data from hydrological reports in "Lena-Yenesei Region."*)

The width at the former city is one kilometer and at the latter 1.5 kilometers. The flow is subject to considerable variation. In 1936 an exceptional flood, due to an ice jam, inundated most of Yeneseisk, covering all but 63 houses. This was the worst flood since 1650, and destroyed a church centuries old. At the same time, exceptionally high water at Krasnoyarsk rose 17 meters on June 30.

River conditions are shown in the following table:

PLACE OF OBSERVATION	BEGINNING OF THAW	BEGINNING OF FREEZE	NUMBER OF DAYS UNFROZEN	THICKNESS OF ICE	DURATION OF OBSERVATION
				cm.	
Krasnoyarsk	Apr. 28	Nov. 13	199		1868–1921
Verkhni Imbatsk	May 16	Nov. 9	177	96	1913–1918
Turukhansk	May 21	Oct. 29	160	130	1913–1918
Dudinka	June 6	Oct. 22	138	150	1913–1918
Golchika	June 10–20	Oct. 23	128	200	1913–1918

VII. THE TAIGA

The forests of the U.S.S.R. cover some four million square miles. Along the Yenesei they extend for 750 miles from latitude 57°N. to 68°N. This is the taiga, a trackless expanse of conifers and whitewoods. Toward the south there is splendid commercial timber of pine and other evergreens, two to three feet in diameter. Farther north the shorter growing season and increasingly adverse conditions reduce the forest to trees less than a foot in diameter whose only eventual use can be for pulpwood.

So vast are these forests that few surveys have been made of their extent. Preliminary studies in the Yeneseisk-Igarka area suggest a total of 130,000,000 hectares, of which 6,000,000 hectares have been explored. The explored area contains 396,000,000 cubic meters of lumber. Additional estimates of conifer reserves in the Angara basin are three times this figure. For at least a decade to come, the annual cut will probably be below the yearly growth.

The taiga is conventionally regarded as a coniferous wilderness. Such it may be elsewhere, but in the vicinity of the Yenesei,

pines alternate with birch. Mixed stands occur, but more commonly there are pure stands of a mile or more across. Fires seem to be uncommon in these boreal forests, but some of the

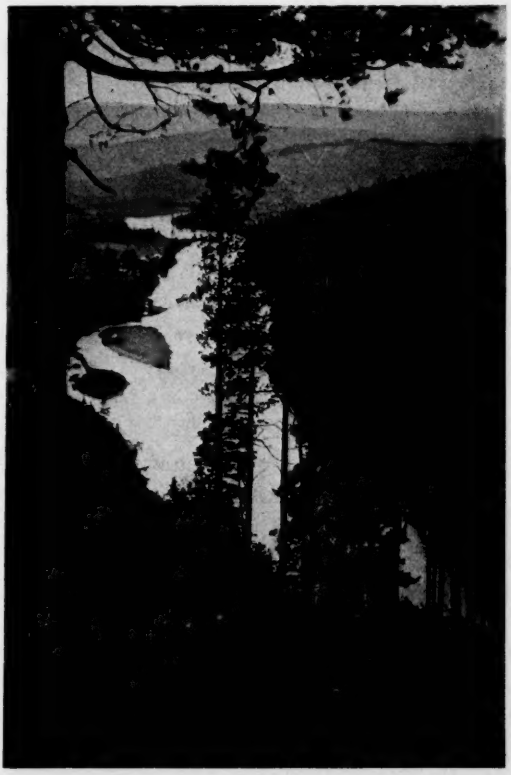


FIG. 27. The best commercial timber of Yeneseiland is along the Angara River near Lake Baikal. This is the source of much of the lumber cut at Igarka. (*Photo from Soyuzphoto.*)

whitewoods may represent an early succession in burnt-over areas. Elsewhere drainage and soil may account for forest variations. One Russian estimate places the conifers at 68 per cent and the deciduous trees 32 per cent.

As seen from the air while flying at elevations of a thousand feet, the forest is open with but little fallen timber. In most instances the surface cover of moss and brush can be seen between the well-spaced trees. To walk through the taiga is relatively easy except for the spongy character of the cover. Bare soil or rock is quite uncommon. Podsol soils predominate, with varying degrees of swampiness and acidity.

Lumbering operations are best developed along the Angara and its tributaries the Koda, Kova, Kishma, Karabula, and Chadobitz, some 300 miles east of the Yenesei. Nowhere within sight of the Yenesei itself is extensive cutting under way, although there is much rafting of logs (Fig. 27).

Saw mills are in operation at Krasnoyarsk, Maklakova, Yeneseisk, and Igarka. South of Krasnoyarsk, most of the timber comes from the Eastern Sayan Mountains, and is either utilized within the area or is shipped over the Trans-Siberian Railroad. North of the railway, the cut is almost entirely for export. Logs are either made into rafts which are consigned to the mills at Igarka, or are cut at Maklakova and Yeneseisk and the sawn lumber shipped to Igarka by barge. Siberian pine is the chief commercial lumber.

The Siberian taiga is the coldest part of Asia, except for high mountains. Minumum temperatures along the Yenesei regularly approach −50°C. during the winter, and the 1930–36 monthly average for January was −26°C. at Igarka. For the same period, Igarka had a yearly average of −8°C. Summers are brief with a short and erratic growing season. During seven years of observation at Igarka, the frost-free period ranged from 75 days (1930) to 128 days (1932), and the total of daily average temperatures within this period fluctuated from 4,743.5 degrees centigrade (1932) to 2,799 degrees (1934). Precipitation is light, with late summer maximum. The yearly average has ranged from 358 millimeters (1933) to 524 millimeters (1935) and averages 406.5 millimeters. Snow covers the ground continuously from the end of September to mid-June.

During 1930 to 1936 climatic conditions at Igarka averaged as follows:

	TEMPERATURE	RAINFALL
	°C.	mm.
January	−24.5	21.9
February	−22.4	15.8
March	−19.2	16.7
April	−10.1	16.8
May	−1.9	25.6
June	7.6	48.1
July	14.4	58.9
August	11.9	57.7
September	5.8	71.4
October	−5.6	45.7
November	−20.7	23.9
December	−27.9	13.9

One of the most striking climatic aspects of the taiga is the widespread presence of permanently frozen ground. During the brief summer months, the soil thaws to the depth of a few feet, but beneath this melted zone, the earth remains frozen to great depths, in some places to hundreds of feet. This frozen subsoil brings many problems in the construction of roads, bridges, and buildings. Trees are shallow-rooted and easily overturned, and cultivated garden plots are slow to warm up in the spring. Once the surface vegetation is removed and cultivation introduced, the depth of summer thaw increases, and the upper limit of permanently frozen ground is lowered.

Almost all of Yeneseiland is within the zone of permanent freezing. The outer limits cross the river near latitude 65°N. and turn southward parallel to the river into Mongolia. The total area within the Soviet Union is 3,728,900 square miles.

The Yenesei itself flows along the eastern margin of the great lowland of Western Siberia, drained largely by the Ob River. No well defined divide separates the two rivers, but the watershed lies so close to the Yenesei through the taiga that something over 95 per cent of its drainage comes from the east.

By means of a canal 25 miles long, now of little or no im-

portance, it was once possible for small boats to pass from the Yenesei to the Ob. The canal connects the Kas, a tributary which enters the Yenesei 120 miles north of Yeneseisk, with the westward flowing Kit River. Both streams are shallow. The divide lies at 115.7 meters.

From the air, the immediate vicinity of the Yenesei is topographically monotonous from Krasnoyarsk to the Arctic Ocean. The river has a well defined channel with banks up to fifty feet high, and the flood plain is commonly narrow. In a few places the right bank is cut in rock, especially where the Yenesei horst approaches the river.

Part of the regional flatness may be due to vast glacially-ponded lakes, formed when continental ice sheets blocked the normal northward flow of the Ob and Yenesei. Drainage from such lakes must have been southeast to the Caspian, but details are lacking.

Parallel to the river and a few tens of miles to the east rises the Central Siberian Platform which is drained by the Verkhni or Upper Tunguska River, usually called the Angara, the Podkamena or Stoney Tunguska in the center, and the Nizhni or Lower Tunguska River to the north. Beneath the tableland lies a shield of ancient pre-Cambrian metamorphic and igneous rocks. Where these are exposed, they are called the Anabar Massif. Elsewhere the shield is buried by a series of coal-bearing Paleozoic rocks which are in turn covered by widespread lava flows. Elevations average a third of a mile, with a maximum of 4,500 feet along the Lena divide.

Coal reserves in the Tungusic Basin are imperfectly surveyed and only developed at a few points along the rivers. On the basis of available data, the reserves of good grade bituminous coal approximate 400,000,000,000 metric tons. Here is thus one of the major coal deposits of the world. Mining operations at Norilsk in the north are beginning to supply fuel for the Yenesei steamers. Heretofore coal has been obtained from the Minusinsk fields, from the Kuznetz basin, and for the lower river from Spitzbergen mines operated by the Soviet Union under a concession from Norway.

The earliest mineral produced in the area was graphite, with 98 tons mined in 1862. Production increased fourteen-fold during the next two years and then sharply declined. The output is now increasing, with a yield of 3,600 tons in 1926. Seventy-seven per cent has come from the Kureika River, near the Arctic Circle, and 9 per cent from the Nizhni Tunguska.

A potential source of energy is the water power produced as the major rivers descend from the highlands. Special attention has been given to the Angara because of its even flow due to Lake Baikal. From the lake to the Yenesei, the Angara drops 380 meters in 1,848 kilometers. In the vicinity of Irkutsk a vast program of electric production has been mapped out for the Third or Fourth Five Year Plan, with a total production of several million kilowatts. This project, Angarastroi, is comparable to plans for the Volga, and rivals anything undertaken in the United States. Coal and electricity, plus timber, may some day form the basis for a great industrial development.

Placer gold is obtained in large but undisclosed amounts from the Angara and other tributaries.

The magnitude of the Yenesei as a river is equally impressive whether viewed from a boat or from aloft. South of the junction with the Angara, the river is three quarters of a mile wide, and the accession of this tributary increases the width to over a mile. North of Turukhansk the Yenesei is more than two miles wide, while in the vicinity of Dudinka the breadth is from three to four miles. Depths generally exceed 50 feet, except in the estuary around Ust Port where there is an extensive bar with 23 feet of water.

During the winter the river freezes some four feet in thickness. Freezing starts during the second half of October in Igarka and reaches Krasnoyarsk in mid-November. While the river is relatively free from ice at Krasnoyarsk for 199 days, the period drops to 160 days at Turukhansk, 138 days at Dudinka, and 113 days in the Yenesei Gulf. With the arrival of spring, the upper river thaws and floods while the mouth is still ice locked. Thus the water level rises at Igarka some 50 to 70 feet in June, but the city lies above this elevation. Fortunately, the channel

is able to carry the discharge, so that the surrounding country is rarely flooded. There appears to be no foundation for misconceptions as to widespread inundation. Where a major ice jam develops, the river may rise rapidly until it overtops the dam, but the maximum flood crest is shortlived.

Settlements in the taiga are small and widely spaced. Only along the waterways is there any sign of human penetration. The forest itself is literally a trackless wilderness. The Yenesei basin probably has half a million square miles of forest without access by wheeled vehicles. Along the river at distances of tens of miles are tiny clearings with a couple of cabins, the homes of trappers and fishermen. Towns are two to three hundred miles apart along the main river, and twice that distance on the tributaries. Even the largest of these are but small clearings in the midst of the forest. The weather-stained log houses and muddy streets are standardized settlement features.

North of Yeneseisk, every sizeable town lies on the east bank, partly because of higher ground due to the right hand deflection of all streams in these latitudes, but largely because of tributary junctions. Although each village serves a large area, there is surprisingly little in the way of commercial activity. Fishing nets along the foreshore and a warehouse for furs reflect the chief occupations. New quarters for the aviation service present a modern note in the larger settlements.

The village of Podkamena Tunguska (Fig. 28), at the junction of the river of the same name, is a tiny clearing with 75 houses, without an identifiable store but with a village Soviet. Verkhni Imbatsk has 60 houses which straggle along the bank for a quarter of a mile. Several dozen cattle find poor forage in the woods, and there are numerous garden plots of potatoes, cabbages, carrots, and flowers. An 80-foot radio mast introduces a new element into the landscape.

Turukhansk (Fig. 29) lies at the junction of the Nizhni Tunguska, latitude 66°N., and is the oldest town on the Yenesei. The first traders came overland from the ancient settlement of Mangazay on the Taz, and settled on the left bank in 1608. This "old town" twice burned, and the present "new town" was

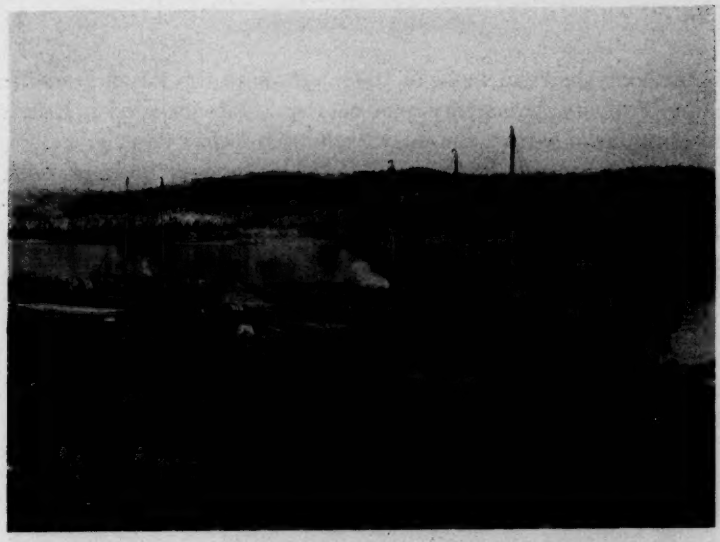


FIG. 28. The Podkamena Tunguska gives its name to the village at the junction of the Yenesei. Drums on the shore contain gasolene for aeroplanes.

FIG. 29. New government building at Turukhansk, with department store at the right. The poster advertises a cinema show.

built along the right bank in 1672. Prior to the Revolution the large Troitsky Monastery was nearby. Two bells with Dutch inscriptions date from the early trade with Amsterdam.

Due to the wasteful hunting of sables during the nineteenth century, and their near extermination, the population of Turukhansk declined from 842 in 1811 to 193 in 1888. In 1824, Siderov reported 46 Russian homesteads north of Turukhansk,

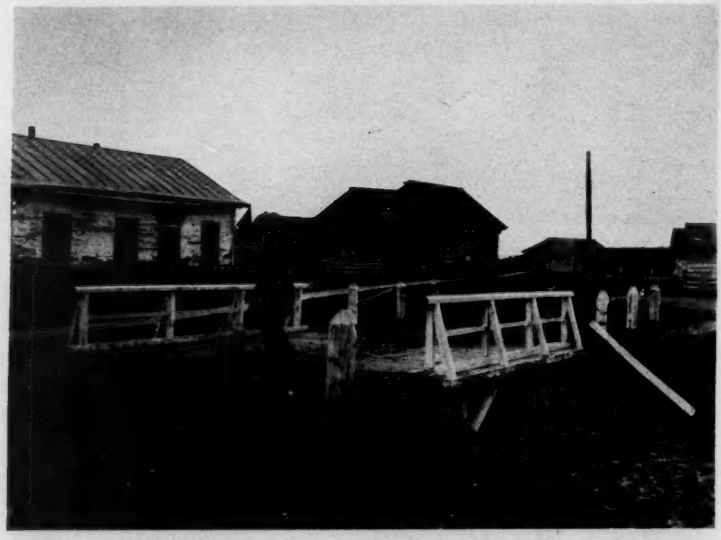


FIG. 30. Like most villages of the north, this Turukhansk street is bleak and muddy. The whitewashed building at the left is a book store.

but by 1863 the number had dropped to 27. The population now numbers 2,500, living in some 300 log houses.

There is a book store with a stock of several thousand volumes, well supplied general stores, a theatre, and administrative buildings. Half a dozen structures bear the name of the Northern Sea Route Administration. Both here and elsewhere to the south are numerous non-Russian natives, chiefly Evenki. Many of them trap furs during the winter, and the annual value of beaver, ermine, fox, squirrel, and other skins amounts to 3,000,000

rubles per year. A modern fox fur farm has been established. Drying racks for fish nets and some seventy small boats along the bank indicate the importance of fishing. Many of the boats are one-piece dugout canoes, scarcely an inch thick and quite flexible.

Aside from half a dozen new buildings, Turukhansk has a drab and weather beaten appearance (Fig. 30). Paint is lacking, and the log houses suffer from the dampness of the ground which characterizes the north. In most houses the lower logs are laid directly on the ground, so that they soon rot. To insulate the buildings, sawdust or earth is piled around the base. Flat log ceilings covered with earth keep in the heat of the large brick stoves, and the open-gabled roof merely sheds the light rain or snow. Muddy streets are bordered by slippery wooden sidewalks, with occasional missing boards.

Turukhansk is the gateway to the Evenki National Okrug, with headquarters at Tura on the Nizhni Tunguska, 800 kilometers eastward. The district covers 1,415,800 square kilometers, and has a population of only 6,000 people.

Igarka is the magic city of the Siberian Arctic, and the pride of the Northern Sea Route Administration. Although 400 miles from the open ocean, this is the chief port of the Yenesei. In 1929 it was a settlement of one house and three natives; by 1937 it numbered 15,000. Igarka's harbor is a deep-water channel behind an island (Fig. 31); nowhere closer to the sea is there a protected anchorage for large steamers. The main dock is 720 meters in length, and visiting boats are as large as 7,700 tons.

In 1937, 45,000 standards (1 standard = 1,980 board feet) of pine lumber were shipped abroad during the brief navigation period in 21 foreign ships. Most of this went to England, Holland, and Germany, but three shiploads were consigned to Durban and Laurenço Marques in South Africa. Production has expanded rapidly within recent years, and plans call for an export of 120,000 standards in 1942. Additional quantities are shipped to Arkhangelsk and other Soviet points. Lumber (Fig. 32) has formed Igarka's sole export, and there have been

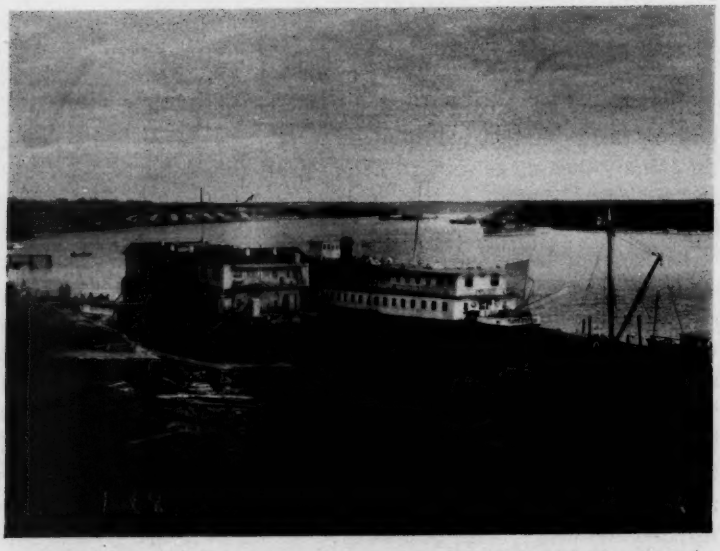


FIG. 31. The port of Igarka lies on a deep channel behind an island, seen at the right. The steamer in the foreground operates to Krasnoyarsk. Lumber wharves line the river for 2,200 feet.

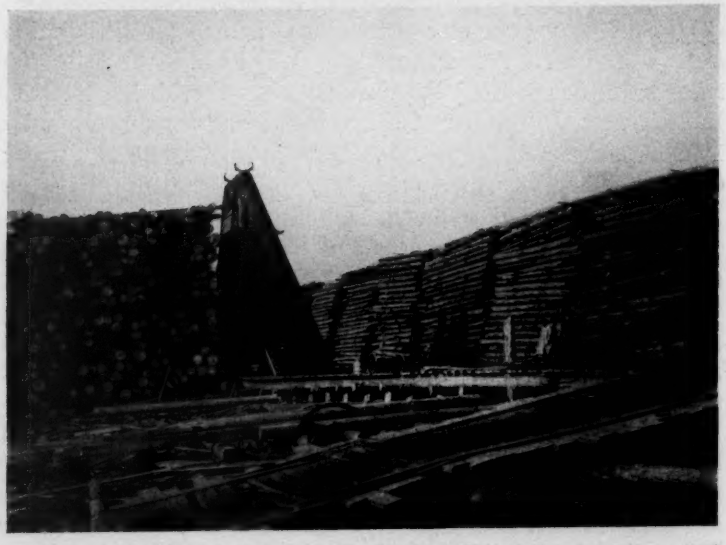


FIG. 32. Piles of logs on the shore at Igarka. This timber has been rafted down the river during the summer and is piled here to be cut during the winter.

virtually no imports. Wood pulp and grain are contemplated for the future.

Most of the logs are rafted from the Angara and its tributaries, but some lumber of lower quality comes from 400 miles up the Podkamena Tunguska. Twelve thousand standards of sawn timber came on barges from the mills at Yeneseisk and Maklakova in 1937; the rest was cut at Igarka (Fig. 33). Great piles

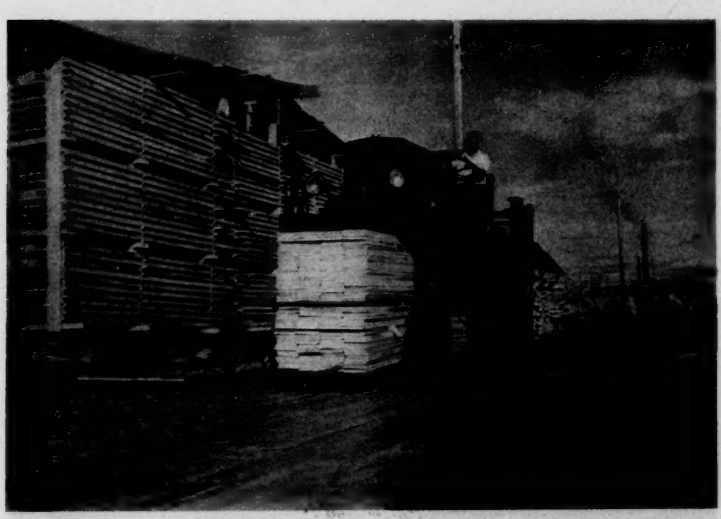


FIG. 33. During the brief navigation season, 18 of these American built lumber trucks at Igarka help to load timber which has been cut in the previous season. (*Courtesy Northern Sea Route Administration.*)

of logs, two to three feet in diameter, are stacked along the shore at Igarka and cut during the winter. The sawn lumber is allowed to season a year before shipment. The mills employ 4,000 workers, of whom 900 are women.

Although but a few years old, Igarka already has an old town (Fig. 34) and a new town. The earliest buildings were low log houses, with floors close to the ground. Experience soon made it clear that warmth from the stoves thawed the underlying frozen soil so that the walls sank irregularly. Newer

buildings thus have adequate insulation beneath the floors. The first houses were south of the mill, whereas most new construction is now to the north, a mile away. The old town still has the city hall, fire department (Fig. 35), opera house and club, and most stores; while the newer city has port and aviation headquarters, hotel, a new theatre, and modern apartments. Elaborate plans have been made, but street patterns even in

FIG. 34. The main street of the old part of Igarka. The building at the left is one of several "universal stores" and carries a wide selection of staple and fancy merchandise.

the new city are still somewhat unorganized. Whereas the present city extends a mile and a half along the river and half that distance inland, the new plans call for a length of three miles. An original promise to supply a copy of the city plan was later refused on the basis that "Since Igarka is close to the frontier, we do not give out maps."

Igarka lies at latitude 67°N., but despite its Arctic position, life goes on without undue difficulties. Attractive young people

wear better clothes than elsewhere along the river, for many of them are recent arrivals from European Russia. No less than 3,200 children are attending 13 schools. Although the original construction work was done by prison labor, there are no convicts employed today.

On account of the mud, all streets are paved with planks. The procedure is to lay scrap cuttings from the mills on the earth,

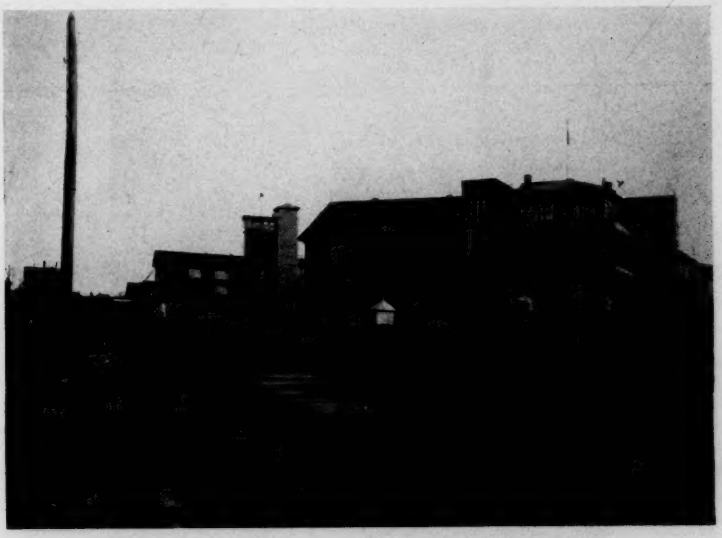


FIG. 35. The town hall and fire department at Igarka. All streets are paved with planks because of the mud.

and over this mattress place logs, and finally three-inch planks. As they settle into the mud, other logs may be inserted to bring the road to a level.

Perhaps nothing better illustrates the audacity of Russia's challenge to the Arctic than the laying of water mains in Igarka's frozen ground. A shallow trench is lined with boards and filled with moss or sawdust around the eight-inch cast-iron mains. To prevent freezing, a steam pipe is placed alongside (Fig. 36). Plans eventually call for a sewage system.

To keep 15,000 people in health presents a major problem in fresh foods. On the island across the harbor is an extensive farm, started in 1932, which sold produce to the value of 1,210,000 rubles in 1936. In preparation for cultivation, new fields are cleared of their trees and moss, and the ground plowed and fallowed for a year, so that the upper limit of frozen ground may be lowered. Before crops can be grown, it is necessary to use

FIG. 36. Water mains in Igarka are kept from freezing by means of a parallel steam pipe; both are enclosed in a moss or sawdust-filled casing.

100 tons of manure per hectare in order to introduce a microflora into the soil.

Because of the short and uncertain growing season, many crops need to be started under glass and otherwise protected. The Arctic sunlight develops large leaves, but the vegetables are often small and watery. Root crops, such as potatoes, turnips, radishes, beets, carrots, onions, and kohlrabi are grown

in open fields. Cabbage, cauliflower and rape are also reasonably successful. Several green-houses, with 1,950 square meters of glass, provide lettuce, cucumbers, tomatoes, onions, and spinach. Cultivated fields now amount to 80 hectares, with a considerable expansion planned. Experimental work is being done on wheat, rye, and oats, but so far grains do not ripen and are used only as feed. Strawberry plants set out in June produced berries

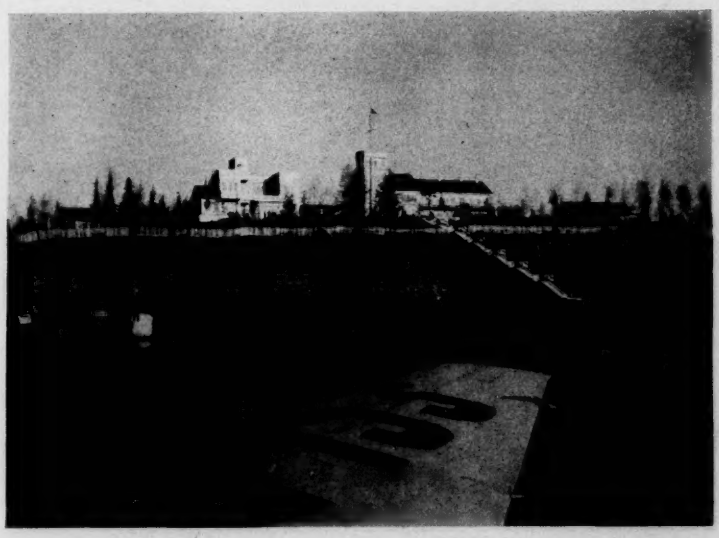


FIG. 37. The banks of the Yenesei at Igarka are everywhere more than 50 feet high. At the right is the port administration building, and at the left the aviation headquarters. The steps are replaced each summer.

over an inch in diameter by September. Apple trees are being trained to grow flat on the ground to escape cold winds. Here and on the mainland are 400 cows, 360 large white English pigs, and numerous horses.

There is no expectation that extensive agriculture will ever reach the Arctic Circle, but it is planned to provide an adequate supply of fresh vegetables for these northern settlements.

From Krasnoyarsk to Igarka is 1,780 kilometers by river, or

1,495 by air. All flying is by hydroplanes which land on the river during the summer, and use skis to alight on the ice in the winter. Without flying, Igarka would be very much cut off (Fig. 37); as it is, the railroad is only one or two days away. Unfortunately, poor weather limits flying possibilities, and travel is expensive. Tickets from Dudinka to Krasnoyarsk cost 450 rubles, plus 2.50 rubles for insurance.

FIG. 38. The northern plain of the Yenesei between Igarka and Dudinka. These innumerable lakes are partially the result of glacial ground moraine and perhaps in part due to unequal melting of the permanently frozen ground.

VIII. THE ARCTIC FRINGE

The northernmost part of Yeneseiland lies in the tundra (Fig. 38). Beyond Igarka the taiga gives way to brush and moss. Trees are either absent or stunted. Localized treeless areas extend south to latitude 60°N., but north of 68°N. they merge into a continuous cover. Tangled brush, bent by snow, borders the lakes and covers the bottomlands; elsewhere there is a spongy mattress of moss into which one sinks six inches

with each step. Below the organic soil, permanently frozen ground is present at depths of a few inches. The reindeer moss *cladonia rangiferina* is the chief form, but there is also *cladonia silvatica, cladonia alpestris, cladonia detormis, alectoria achrilevca* and *ceturia nevalis.* Several natural grasses provide meagre pasturage for horses and cows. Glacial lakes dot the rolling landscape.

FIG. 39. An Evenki wigwam of birch bark on the river bank at Turukhansk. Snow on the ground in mid-September.

Native tribes inhabit both ends of the Yenesei Valley. Those in the north are the Nentsi, Evenki (Fig. 39), and to a lesser extent Sakha and Yakuts. Many of these people have been called Samoyeds, originally a term of derision because some were cannibals. Two occupations provide their major source of livelihood: fishing and gathering furs. During the summer months the nomads pitch their birch bark wigwams along the rivers and catch fish. During the winter they migrate to the interior in search of fox, ermine, sable, squirrel and other fur

bearing animals which they catch in traps. In 1936, the total catch shipped from the Taimyr Okrug was valued at 4,800,000 rubles. Each family has from 10 to 100 reindeer (Fig. 40), which are used along with some dogs for pulling sleds. Sixty per cent of these natives are now collectivized, and there are two reindeer-breeding stations. Ivory from mammoth tusks

FIG. 40. Reindeer furnish the principal means of transportation during the long winter. This is a native trapper making his rounds. (*Courtesy Northern Sea Route Administration.*)

is still an important export, with two tons shipped in 1936. Some of these tusks are 7 inches in diameter and up to 17 feet long (Figs. 41, 42).

Rigorous climate makes agriculture all but impossible. A field of potatoes in Dudinka was frost killed early in September before ripe, but experimental agriculture is being continued.

The northernmost limit of successful open field cultivation is at Potavpo, midway between Igarka and Dudinka. Grain grown here so far does not ripen but is used for feeding horses and cattle. A local wild onion, now being domesticated, and a few other root crops are all that can be grown.

Dudinka is the capital of the Taimyr National Okrug and the principal city north of Igarka. Unlike the latter, which

FIG. 41. Until recently, the native population of the Taimyr Peninsula have had no medical, educational or cultural opportunities. All of these are now available. (*Courtesy Northern Sea Route Administration.*)

is a newly planned development with little contact with its immediate hinterland, Dudinka is an important focal point. An old man of 71 years, born in Dudinka, remembers when it had but three houses. He reported his father as saying that people first came here for furs and fish. Many of the buildings were built during the Second Five Year Plan, and today there are some 2,500 people in the town.

FIG. 42. Samoyed young pioneers beyond the Arctic Circle, the Siberian equivalent of Eskimo boy scouts. (*Courtesy Northern Sea Route Administration.*)

The extent of Dudinka's urbanization is indicated in the following inventory of its principal activities (Fig. 43):

4 stores, one with warehouse
3 restaurants
2 banks
2 schools, middle and adult
1 bookstore
1 newspaper office, circulation 3,000
1 club and theatre
2 political headquarters, *rayon* and *okrug*
1 aviation base
1 port office
1 post and radio office
3 Northern Sea Route offices; trade, fish, and furs
2 radio stations
1 hospital, 20 beds
1 reindeer veterinary office
1 meteorological station
1 fire department
1 police department
1 drug store
1 court office

The frost free period at Dudinka averages less than 60 days; in 1937 from June 24 to August 18. The temperature dropped to −41°C. on February 28, 1937, and the monthly average was −23°C. The highest temperature of the preceding summer was on July 24 with 21.9°C. Every month has from 64 to 87 per cent cloudiness. The record for 1936 was as follows.

	PRECIPITATION	DAYS OF PRECIPITATION	AVERAGE TEMPERATURE	DAYS WITH FULL SUNSHINE
	mm.		*C.°*	
January	1.7	8	−30.8	2
February	6.5	15	−24.2	4
March	3.6	9	−20.6	5
April	4.6	9	−10.9	4
May	9.7	12	−6.8	3
June	33.1	14	3.1	0
July	48.0	13	12.0	1
August	60.7	12	9.2	5
September	44.4	18	6.6	1
October	14.8	18	−5.4	2
November	1.9	7	−22.9	5
December	9.5	16	−18.4	6

During the short summer, surface thawing produces incredibly muddy streets, and the frozen sub-soil prevents underground drainage. One must expect to sink 6 to 10 inches in crossing from one sidewalk to another.

The shove of river ice piles up a high rampart along the shore, as much as fifty feet above normal water level. This natural rampart forms a levee which protects the slightly lower land behind from the spring floods. Only once have parts of Dudinka been inundated. A splendid kame and kettle topography lies north of the city, marking a recessional moraine.

FIG. 43. An old church and the new aviation headquarters at the principal street corner in Dudinka. Sidewalks line the streets, but one must wade through deep mud to cross to the other side.

Dudinka lies at the mouth of a small tributary along which wharves have been constructed. It is planned to dredge the sand bar and create a small port for river vessels.

It may be interesting to note that a duck recently shot in Dudinka carried a band from Bombay, India.

In her quest for mineral independence, the Soviet Union has reached into the Yenesei tundra and is developing a nickel mine at Norilsk, 112 kilometers east of Dudinka. In addition to nickel, coal is already being mined and there are deposits of

copper, cobalt, platinum, lead and zinc. A railroad (Fig. 44) was completed in 1937 under the Commissariat of the Interior, using convict labor. Some 8,000 prisoners were reported to be working on the construction project. Farther east, near the mouth of the Khatanga River salt and oil are being developed at Nordvyk.

FIG. 44. Construction camp for the Norilsk Railroad at Dudinka. About 8,000 convicts were working on this project in 1937.

In 1917 when it was proposed to develop a port for the Yenesei, Ust Port was founded near latitude 70°N. Unfortunately the location provided a poor harbor, and the town now has but 500 people; its chief business is a fish cannery.

Dickson Island lies at the entrance to the Yenesei Gulf, and is both the terminus for all river shipment and an important port of call for navigation from Murmansk to Vladivostok. The island (Fig. 45) is a barren expanse, nearly destitute of soil and vegetation. There is a sheltered harbor with wharf, but the entrance admits no boats drawing over 24 feet. Half-buried greenhouses

grow fresh vegetables with artificial heat and light, using electricity generated by arctic storms.

The development of navigation from the Atlantic to the Pacific is one of the major objectives of Soviet transport plans. Accordingly, the Northern Sea Route Administration is a vast undertaking, comparable in scope to the British East India Company. In addition to its task of opening the Arctic Ocean, it has charge of all economic exploitation north of latitude 62°N. in Siberia.

In 1932, the Sibiryakov made the first voyage from Arkhangelsk to Vladivostok in a single season. Since then ice breakers,

FIG. 45. Radio station on barren Dickson Island at the entrance to the Yenesei estuary. (*Photo from Soyuzphoto.*)

aeroplanes, and detailed weather forecasting have made possible an increasing amount of through traffic. In 1937, twenty vessels made the complete voyage, and about 100 came to the mouth of the Ob, Yenesei or Lena.

While navigation through the Kara Sea normally ends October first, long range weather forecasting is used to extend the period where possible. In 1937, favorable predictions extended the period until October 16, but bad ice conditions around Cape Chelyuskin trapped several vessels, including the ice breaker Syedoff which subsequently drifted toward the pole and broke the northward record of the Fram. It is hoped that within a

few years Arctic navigation will be dependable, and thus release Siberian rivers from their ice barriers. With improved facilities, a considerable volume of ocean-borne commerce may use the Yenesei River.

IX. BIBLIOGRAPHY

Bolshoi Soviet Encyclopedia, Moscow (in Russian).

CARRUTHERS, DOUGLAS, "Unknown Mongolia," I, 27–117, Philadelphia: Lippincott, 1914.

CRESSEY, GEORGE B., "News From Siberia," *Harpers Magazine, 177*, 148–157 (1938).

———, "The Soviet Union Looks Eastward," *China Journal, 29*, 89–92 (1938).

———, "Permanently Frozen Ground in Siberia," *Journal of Geology, 47*, 472–488 (1939).

GRUBER, RUTH, "I Went to the Soviet Arctic," New York: Simon and Schuster, 1939.

HALL, H. U., "A Siberian Wilderness: Native Life on the Lower Yenesei," *Geographical Review, 5*, 1–21, 558 (1918).

KALITONOV, N. L., AND KOLOSOVSKY, N. N., Editors, "Angara-Yenesei Problems," Work of the First All-Union Conference on the Distribution of Productive Forces in U.S.S.R., Vol. XVI, Moscow: State Planning Commission, 1922 (in Russian).

MATTERS, LEONARD, "Through the Kara Sea," London: Skeffington, 1931.

NANSEN, FRIDTJOF, "Through Siberia, the Land of the Future," New York: Stokes, 1914.

RODEVICH, V. M., Editor, "Lena-Yenesei Region," Reference Book on the Water Resource of the U.S.S.R., Vol. XVI, XVII, Leningrad: Central Administration of the Hydro-Meteorological Service U.S.S.R., State Hydrological Institute, 1936 (in Russian).

SMOLKA, H. P., "The Economic Development of the Soviet Arctic," *Geographical Journal, 89*, 327–343 (1937).

———, "Forty Thousand Against the Arctic," New York: Morrow, 1937.

TARASENKOV, G. N., "Turukhansk Krai," Economic Survey with Historical Outline, Krasnoyarsk, 1930 (in Russian).

TETIAEV, M., Editor, "Le Pays de Krasnoyarsk," Moscow: XVII-e Congrès Géologique International, 1937 (in French).

X. YENESEI TRANSECT FROM THE ARCTIC TO TANNA TUVA

Based on aerial traverse and miscellaneous data. All settlements to 1936 shown by black rectangles.

FIG. 46

Ust Port is a village of 500 at the southern end of the Yenesei estuary. Fish cannery. No port facilities.

Population largely nomadic fishers and hunters, native tribes with domesticated reindeer. Widely spaced.

Dudinka is the commercial and political center for the Taimyr peninsula. Population 2,500. Railroad eastward to coal and nickel mines at Norilsk. Unsuccessful attempts at agriculture. Terminal moraine with kame and kettle topography back of town. Wharves along tributary, bar to be dredged.

River rises forty to fifty feet in brief spring ice jams, but does not inundate countryside. No indication here or elsewhere of widespread flooding.

A land of innumerable lakes, literally tens of thousands, some a mile across or more. Lakes locally cover one third to one fourth of entire area. Shapes irregularly circular with smoothed shorelines. Definitely not old river channels; either ground moraine or due to subsidence from irregular melting of frozen ground. No kames seen.

Settlements small and widely spaced, limited to river bank.

Much unforested tundra, elsewhere trees cover but one third of area. Birch dominant. Near latitude 69°, trees drop to five per cent.

River three to four miles across. Occasional sand bars. No signs of true meanders.

Small lakes extend to the far horizon, covering a third of the surface.

Open forest, with trees tens of feet apart, less than six inches diameter and thirty feet high.

Igarka is a new modern city with extensive lumber mills. Population 15,000. Good harbor with wharves behind island. Cleared land limited to the environs of the city. Extensive agricultural station on island.

Hay is cut on the sand bars, which are relatively stabilized.

Scattered settlements contain fewer than 15 houses.

Forest cover is the "lesser taiga" and "wooded tundra", with areas of open tundra.

Numerous lakes up to one half miles in diameter, seemingly glacial ground moraine. Unrelated to river except near present channel. Abundant to the horizon, resembling Minnesota. Local relief a few tens of feet.

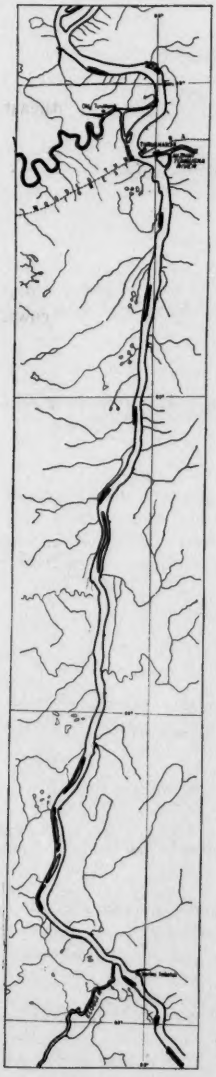


FIG. 47

Turukhansk lies at the boundary of the wooded tundra and the forest. An old sprawling city of 300 houses and 2,500 people; commercial and administrative center. Junction of the Lower Tunguska, and the terminus of the road and telegraph line. The town is built on a fifty foot terrace; river bank shows thirty feet of (glacial ?) gravel overlain by twenty feet of horizontally bedded (lacustrine ?) sand.

Settlements are about ten miles apart and only along the river, usually but two or three houses. One cluster of twenty-five houses, another fifteen. Clearings small and uncultivated. Fishing and trapping the chief occupation.

The forest is continuous but open, some fallen trees but no dense tangle. Coniferous usually in the minority, smaller than farther south.

The Yenesei averages two miles in width.

The country is nearly flat, with little terrace development. Possible ground moraine with numerous lakes.

Numerous tundra areas in the midst of the taiga, some with small lakes and irregular one hundred foot polygboden or frost ridges.

Verkhni Imbatsk has sixty unpainted log houses on a forty foot terrace. Small vegetable gardens. No wheeled vehicles. Aviation base and radio station. River bank contains large striated glacial cobbles; mostly fine grained rocks, some amygduloidal.

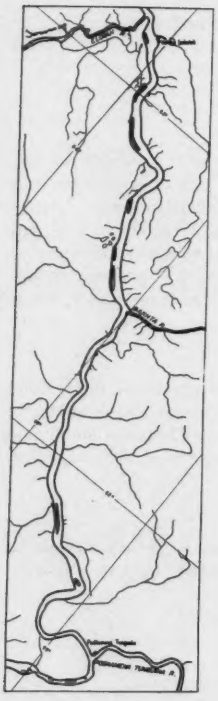


FIG. 48

The thin trace of the cart road follows the east bank south to latitude 63° where it crosses to the west bank by a swing ferry. Little traffic.

One forty-house village with twenty-five acres cleared, another with twenty-five houses.

Coniferous trees are generally in the minority. In places whitewoods run to four-fifths, elsewhere the reverse.

A few small lakes away from the river.

Occasional linear patterns with south and southeast orientation suggest glacial fluting.

River two to three miles broad. Flood plain shows scroll pattern of old channels.

Podkamena Tunguska is at the junction of the river of the same name. Seventy-five houses along one muddy street. Town lies on a forty foot terrace, with the hundred foot Torgashinsky terrace nearby. Fishing nets, cows, Evenki wigwams, aviation base.

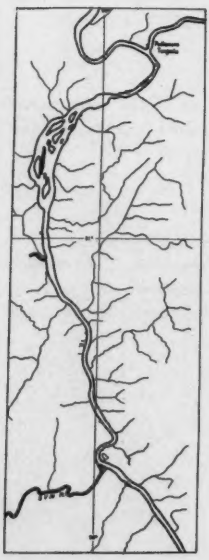


FIG. 49

Trees six to eight inches in diameter, thirty feet high. Occasional park-like natural clearings with trees, low shrub, and grass.

One area of cultivated fields several miles in extent, west of river.

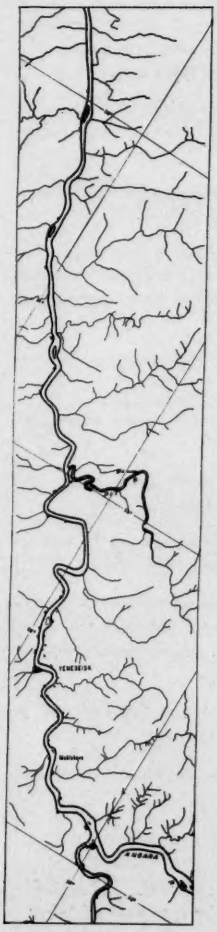
The country is flat for tens of miles to the horizon, both east and west. Well drained.

The channel is fixed, and forest pattern shows no indication of former courses. Broad curves but no meanders. One example of a fifty foot terrace in contorted and metamorphic rock.

Riverside settlements are widely spaced; the largest has 100 houses and a clearing two miles long and two hundred yards wide. Another clearing with 25 houses and a few acres of cultivated land; settlements commonly have but two or three houses for fishermen. Hay is more important than grain.

Flood plain islands are covered with grass which is cut for hay. Forest commences at the river's bank.

Whitewoods are generally more abundant than conifers.



Forest wilderness, nearly without settlement or signs of man; trackless but not dense.

A few areas of sparse forest or wooded tundra, apparently due to wet soil. Occasional burnt-over tracts.

Forest about evenly divided between areas of solid conifers, usually pine or larch, and whitewoods or mixed types. Sharp vegetation boundaries give distinct color contrast.

River two miles broad. Well defined single channel in broad curves, with occasional old channels now grass-covered. Scattered terrace development, but high banks uncommon.

Placer gold mines on the eastern tributaries.

Well within the vast taiga. Settlements few and along river.

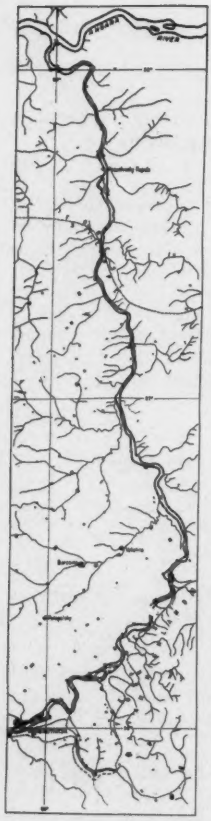
The channel is usually over 30 feet deep, but bed rock produces small rapids near latitude 59°N.

The old city of Yeneseisk extends along the left bank for three quarters of a mile. Several large churches and a lumber mill. Surrounded by considerable farm land.

Maklakova village with large lumber mill on west bank.

Junction of the Angara or Upper Tunguska, wider and with greater volume than the Yenesei.

FIG. 50



Cultivated fields widely spaced and almost entirely along the river, elsewhere cleared land amounts to but two or three per cent. Plowed fields show black soil.

High hills border the west bank. Entirely wooded with the forest to the water's edge; three-fifths birch and white-woods, two-fifths conifers.

Tributary streams all meander; the smaller the stream the more intricate the pattern.

Scroll flood plain covered with grass, a half mile wide on each side of the river. Channel well stabilized without frequent shifting or braiding. Large semi-permanent sand bars.

Four-fifths of the land is in forest; elsewhere hay is more important than cultivated crops.

The Torgashinsky terrace is well developed, about 100 feet above the river.

Rolling countryside. Clearings with grain, hay and fallow cover fifty per cent, alternating with forest.

Agricultural villages dot the countryside, each with its white church. Most settlements border streams.

The land north of the Trans-Siberian Railway is a cultivated steppe with occasional patches of forest on the upper levels, especially east of the river. Birch and pine predominate, with no dimension lumber.

Extensive urban developments along the railroad on both sides of the river.

The Yenesei leaves the Eastern Sayan Mountains at Krasnoyarsk.

FIG. 51

Note: Figs. 46–51 are reduced from maps on a scale of 1:250,000. All settlements are shown. The maps do not adequately indicate the many small lakes in the northern area.

Latitude 56°N.	The Yenesei cuts through the Eastern Sayan Mountains in a series of narrow valleys, local relief a thousand feet. Current swift, seven miles per hour at Krasnoyarsk. Channel tens of feet deep. Projected dam 950 meters long, 62 meters high, to develop 1,350,000 kilowatts. Exceptional terrace development with levels at 2, 6, 9, 15, 20, 30 and 70 meters. Extensive coniferous forest on many hills, especially north slopes.
Latitude 55°N.	Novoselovo, local shipping center, northern edge of steppe. Steppe plains and rolling hills. Loess with a few sand dunes. Local cultivation with occasional new large fields miles in extent. Some fields fallow-plowed to conserve moisture. Small grain elevators at many river landings. Gasolene tanks for new machine tractor stations. Considerable river traffic from Minusinsk to Krasnoyarsk. Channel braided but well defined and marked with beacons. A few sand bars.
Latitude 54°N.	Minusinsk, an old town of 25,000 people on the right bank, commercial center. Abakan at junction of tributary of same name. Railroad terminus. Nearby coal mines at Chernogorsk. Significant agricultural expansion, fertile chernozem soils, mechanized agriculture. Farm villages are widely spaced. Large uncultivated areas remain. Limited and uncertain rainfall.
Latitude 53°N.	Minusinsk Basin, with rolling hills and salt lakes. Steppe pasturage for nomadic Khakass. Herds of cattle, sheep and horses. Trees limited to higher north slopes, elsewhere short grass.
Latitude 52°N.	Western Sayan Mountains, rising to 10,000 feet. Forested from 2,000 to 7,000 feet; small glaciers on summits. Yenesei cuts through mountains in canyons, barely navigable; impassable at Bolshoi Porog rapids. One steamer operates above rapids into Tanna Tuva.

Some suggested experiments for the graphic recording of speech vibrations; Robert James Kellogg. 14 pp., 6 figs.
The manipulation of the telescopic alidade in geologic mapping; Kirtley F. Mather. 46 pp., 13 figs.
The importance of drainage area in estimating the possibilities of petroleum production from an anticlinal structure; Kirtley F. Mather and Maurice G. Mehl. 4 pp., 2 plates.

Articles 9–12, pp. 147–224; May, 1920 ..... $0.75
Psychological factors in vocational guidance; Thomas A. Lewis. 10 pp.
The use of models in the interpretation of data for determining the structure of bedded rocks; Maurice G. Mehl. 12 pp., 6 figs., 2 plates.
Some suggestions for indicating drilling operations; Maurice G. Mehl. 6 pp., 3 figs.
The Kimmswick and Plattin limestones of Northeastern Missouri; Aug. F. Foerste. 50 pp., 3 plates.

Articles 13–16, pp. 225–329; September, 1921 ..... $0.75
Education for scholarship; William E. Castle. 9 pp.
The cytology of the sea-side earwig, Anisolabis maritima Bon., part 1; Sidney I. Kornhauser. 13 pp., 3 plates.
Notes on Arctic Ordovician and Silurian cephalopods; Aug. F. Foerste. 60 pp., 9 plates.
Revolution vs. evolution: the paleontologist renders his verdict; Kirtley F. Mather. 18 pp.

VOLUME 20

Articles 1–3, pp. 1–36; November, 1922 ..... $0.50
A review of the biology of sex-determination; Sidney I. Kornhauser. 21 pp., 8 figs.
The Meander patterns of Rios Securé and Mamoré, Eastern Bolivia; Kirtley F. Mather. 7 pp., 2 figs.
Primitive musical instruments of the Denison Collection; Karl H. Eschman. 10 pp., 3 plates.

Articles 4–8, pp. 37–186; June, 1923 ..... $0.75
Notes on Medinan, Niagaran, and Chester fossils; Aug. F. Foerste. 84 pp., 13 plates.
The egg and larvae of Hesperia juba Bdv.; A. W. Lindsey. 7 pp., 1 plate.
The occultation of Venus by the Moon on January 13, 1923; P. Biefeld. 4 pp., 1 plate.
A botanical survey of the campus of Denison University; Dwight Munson Moore. 23 pp., 7 figs., 3 plates.
The underground migration of oil and gas; Kirtley F. Mather. 31 pp., 1 fig.

Articles 9–13, pp. 187–383; December, 1924 ..... $1.25
Trichoptilus pygmaeus Wism. and the Neuration of the Family Pterophoridae; A. W. Lindsey. 6 pp., 6 plates.
Notes on American Paleozoic Cephalopods; Aug. F. Foerste. 76 pp., 23 plates.
A Report on the Theory of Relativity (Einstein Theory); Paul Biefeld. 20 pp.
Some Problems of Taxonomy; A. W. Lindsey. 18 pp., 1 plate.
Notes on the Geology of Giles County, Virginia; George D. Hubbard and Carey G. Cronels. 72 pp., 1 plate.

VOLUME 21

Articles 1–3, pp. 1–116; March, 1925 ..... $1.25
Notes on Cephalopod Genera; Chiefly Coiled Silurian Forms; Aug. F. Foerste. 70 pp., 23 plates.
The Cornell University Entomological Expedition South America of 1919–1920. Scientific Results No. II. Hesperiodea; A. W. Lindsey. 44 pp., 6 plates.
Photographic Record of the Partial Solar Eclipse of January 24, 1925; Paul Biefeld. 2 pp., 1 plate.

Article 4, pp. 117–283; September, 1925 ..... $1.50
The Agricultural Geography of the Salt Lake Oasis; Charles Langdon White. 167 pp., 34 figs.

Articles 5–7, pp. 285–404; September, 1926 ..... $1.25
Actinosiphonate, Trochoceroid and other Cephalopods; Aug. F. Foerste. 100 pp., 22 plates.
Brachiopods from the St. Clair Limestone, Arkansas; Norman L. Thomas. 13 pp., 1 plate.
Notes on the Preparation of Hydrogen Sulfide and Hydrogen Iodide; W. C. Ebaugh. 2 pp.

VOLUME 22

Articles 1–4, pp. 1–135, March, 1927 ..... $1.50
Ordovician and Silurian Cephalopods of the Hudson Bay Area; Aug. F. Foerste and T. E. Savage. 108 pp., 24 plates, 1 map.
Notes on Phylogeny in Erynnis Schr. (Thanaos Auct.); A. W. Lindsey. 7 pp., 1 fig.
The Blue Ridge of Southern Virginia and Western North Carolina; Frank J. Wright. 17 pp., 4 figs., 2 plates.
Gravels of the Blue Ridge; Frank J. Wright. 3 pp., 1 fig.

Articles 5–9, pp. 137–193, October, 1927 ..... $1.00
Science and Religion (Address); Robert A. Millikan. 10 pp.
Forty Years of Scientific Thought Concerning the Origin of Life (Address); Kirtley F. Mather. 11 pp.
Darwin as a Pioneer in Evolution (Address); George A. Dorsey. 14 pp.
Science and Living (Address); C. Judson Herrick. 9 pp.
Founding of the Denison Scientific Association (Address); Alfred D. Cole. 6 pp.

VOLUME 23

Articles 1–2, pp. 1–126, January, 1928 ..... $1.50
American Arctic and Related Cephalopods; Aug. F. Foerste. 110 pp., 29 plates.
Apatodonosaurus, A New Genus of Ichthyosaurs from the Jurassic of Wyoming; M. G. Mehl. 15 pp., 2 figs., 6 plates.

Articles 3–5, pp. 127–230, July, 1928 ..... $1.50
Some Brachiopods from the St. Clair Limestone, Arkansas; Norman L. Thomas. 13 pp., 1 plate.
The Phytosauria of the Wyoming Triassic; M. G. Mehl. 32 pp., 9 figs., 3 plates.
A Restudy of some of the Ordovician and Silurian Cephalopods described by Hall; Aug. F. Foerste. 58 pp., 8 plates.

Articles 6–8, pp. 231–355, December, 1928 ..... $1.50
Hesperioidea from the Kartabo District of British Guiana; A. W. Lindsey. 5 pp., 5 figs.
A Restudy of American Orthoceonic Silurian Cephalopods; Aug. F. Foerste. 85 pp., 28 plates.
The Erosional History of the Blue Ridge; Frank J. Wright. 24 pp., 10 plates.

VOLUME 24

Articles 1–5, pp. 1–113, April, 1929 ..... $1.50
Hypoparia and Opisthoparia from the St. Clair Limestone, Arkansas; Norman L. Thomas. 20 pp., 1 plate.
Ordovician and Silurian of American Arctic and Subarctic Regions; Aug. F. Foerste. 54 pp., 2 plates.
Location Factors in the Iron and Steel Industry of Cleveland, Ohio; Charles Langdon White. 16 pp., 4 figs., 1 plate.
A Photographic Record of the Total Eclipse of the Moon; Paul Biefeld. 2 pp., 1 plate.
Basalerina, A New Holliniform Ostracode Genus, with Description of New Pennsylvanian Species from Texas and Oklahoma; Raymond C. Moore. 15 pp., 3 plates.

Articles 6–9, pp. 115–264, August, 1929 ..... $1.50
Some Proparia from the St. Clair Limestone, Arkansas; Norman L. Thomas. 14 pp., 2 plates.
Cephalopods of the Red River Formation of Southern Manitoba; Aug. F. Foerste. 107 pp., 29 plates.
A Large Fish Spine from the Pennsylvanian of North Central Texas; Raymond C. Moore. 7 pp., 1 plate.
Location Factors in the Iron and Steel Industry of the Buffalo District, New York, Charles Langdon White. 20 pp., 6 figs.

Articles 10–12, pp. 265–427, December, 1929 ..... $1.50
Three Studies of Cephalopods; Aug. F. Foerste. 117 pp., 23 plates.
A New Genus of Mosasaurs from Mexico, and Notes on the Pelvic Girdle of Platecarpus; M. G. Mehl. 18 pp., 5 figs., 4 plates.
Stream Piracy near Asheville, N. C.; Frank J. Wright. 6 pp., 1 fig., 1 plate.
Motor Vehicle Transportation Cost and its Relation to Highway Finance; Bruce D. Greenshields. 6 pp., 1 fig.

VOLUME 25

Articles 1–3, pp. 1–164; April, 1930 ..... $1.50
Port Byron and Other Silurian Cephalopods; Aug. F. Foerste. 124 pp., 2 figs., 24 plates.
The Iron and Steel Industry of Youngstown, Ohio; Charles Langdon White. 22 pp., 7 figs.
New Species of Bryocoans from the Pennsylvanian of Texas; Raymond C. Moore. 17 pp., 1 plate.

Articles 4–5, pp. 165–200, August, 1930 ..... $1.00
Visual Localisation in the Horizontal Plane; Winford L. Sharp. 9 pp.
Petroleum Products for Internal Combustion Engines; Milton Finley. 26 pp., 3 figs.

Articles 6–7, pp. 201–299, December, 1930 ..... $1.00
The Actinoceroids of East-Central North America; Aug. F. Foerste and Curt Teichert. 96 pp., 33 plates.
The Presence of Nybyoceras in South Manchuria; Riuji Endo. 3 pp., 1 plate.

VOLUME 26

Article 1, pp. 1–142; April, 1931 ..... $1.50
The Hesperioidea of North America; A. W. Lindsey, E. L. Bell and R. C. Williams, Jr. 142 pp., 33 plates.

Article 2, pp. 143–250; December, 1931.....$1.50
The Older Appalachians of the South; Frank J. Wright. 108 pp., 38 plates.

VOLUME 27

Article 1, pp. 1–46; June, 1932.....$1.50
The Geomorphic Development of Central Ohio (Part I); Henry S. Sharp. 46 pp., 1 fig., 6 plates.
Article 2, pp. 47–136; December, 1932.....$1.50
Black River and Other Cephalopods from Minnesota, Wisconsin, Michigan, and Ontario (Part I); Aug. F. Foerste. 90 pp., 31 plates.

VOLUME 28

Articles 1–3, pp. 1–154; April, 1933.....$1.50
Black River and Other Cephalopods from Minnesota, Wisconsin, Michigan, and Ontario (Part II); Aug. F. Foerste. 146 pp.; for plates *cf.* This Journal, Vol. 27, Art. 2 (December, 1932).
A Study of the Change in Mass of the Anode of the Aluminum-Lead Cell; Charles E. Welling. 5 pp.
Balancing Chemical Equations—The Contribution of Otis Coe Johnson (1880); W. C. Ebaugh. 4 pp., 1 plate.
Article 4, pp. 155–248; October, 1933.....$1.00
The Ordos Desert of Inner Mongolia; George B. Cressey. 94 pp., 32 figs., 1 plate.

VOLUME 29

Article 1, pp. 1–105, April, 1934.....$1.25
The Newer Appalachians of the South (Part I); Frank J. Wright. 105 pp., 28 plates, 3 figs.
Article 2, pp. 107–193, August, 1934.....$1.25
Silurian Cyrtoconic Cephalopods from Ohio, Ontario, and Other Areas; Aug. F. Foerste. 86 pp., 14 plates.
Articles 3–4, pp. 195–238, December, 1934.....$1.00
Evidence of Ice Action in the Teays Valley, West Virginia; Julian J. Petty. 10 pp., 4 figs.
The Earlier History of the BULLETIN OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY; Aug. F. Foerste. 23 pp.

VOLUME 30

Articles 1–2, pp. 1–118, April, 1935.....$1.00
Big Horn and Related Cephalopods; Aug. F. Foerste. 96 pp., 22 plates.
New Light Sources for Photographic Purposes; W. E. Forsythe. 22 pp., 7 figs.
Articles 3–4, pp. 119–230, August, 1935.....$1.00
Correlation of Silurian Formations in Southwestern Ohio, Southeastern Indiana, Kentucky and Western Tennessee; Aug. F. Foerste. 87 pp.
A Study of the Phenomenon of Wetting Films; C. W. Chamberlain and Kenneth Lyle Warren. 25 pp., 4 plates, 1 fig.
Articles 5–6, pp. 231–303, December, 1935.....$1.00
The Cephalopods of the Maquoketa Shale of Iowa; Aug. F. Foerste. 27 pp., 11 plates.
New Genera of Ozarkian and Canadian Cephalopods; E. O. Ulrich and Aug. F. Foerste. 32 pp., 1 plate.

VOLUME 31

Articles 1–2, pp. 1–92, April, 1936.....$1.00
Hierosaurus coles; a new aquatic Dinosaur from the Niobrara Cretaceous of Kansas; M. G. Mehl. 20 pp., 3 plates.
Silurian Cephalopods of the Port Daniel Area on Gaspé Peninsula, in Eastern Canada; Aug. F. Foerste. 72 pp., 23 plates.
Article 3, pp. 93–142, August, 1936.....$1.00
The Newer Appalachians of the South (Part II): South of the New River; Frank J. Wright. 50 pp., 6 figs., 32 plates.
Articles 4–6, pp. 143–259, December, 1936.....$1.00
A Study of the Vestigial Air Bladder in the Darter (*Catonotis flabellaris rafinesque*); George David Morgan. 16 pp., 10 plates.
We Must Shape our New World (Commencement Address); Arthur Holly Compton. 11 pp.
Later History of the JOURNAL OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY; Kirtley F. Mather. 25 pp.
Report of the Permanent Secretary of the DENISON SCIENTIFIC ASSOCIATION. 52 pp.

VOLUME 32

Articles 1–2, pp. 1–131, April, 1937.....$1.00
History of *Theta* Chapter of Ohio, Phi Beta Kappa (1911–1936); Willis A. Chamberlin. 69 pp., 2 figs.
The Tungsten Filament Incandescent Lamp; W. E. Forsythe and E. Q. Adams. 72 pp., 10 figs.
Articles 3–7, pp. 133–207, August, 1937.....$1.00
Science and the College (Commemoration Address); Carey Croneis. 12 pp.
Our Endowment (Commemoration Address); C. Judson Herrick. 9 pp.
Science—Man's Liberator (Commemoration Address); William E. Wickenden. 10 pp.
The Application of Physics to Modern Hydrographic Surveying; (Commemoration Address); Herbert Grove Dorsey. 22 pp., 10 plates.
An Annoted Check-list of Birds Recorded at Granville, Licking County, Ohio; Ward M. Klepfer and William J. Taylor. 21 pp., 1 plate.
Article 8, pp. 209–337, December, 1937.....$1.00
Upper Carboniferous Crinoids from the Morrow Subseries of Arkansas, Oklahoma and Texas; Raymond C. Moore and Frederick N. Plummer. 106 pp., 37 figs., 5 plates.
Report of the Permanent Secretary of the DENISON SCIENTIFIC ASSOCIATION. 10 pp.

VOLUME 33

Article 1, pp. 1–60, April, 1938.....$1.00
The Telescopic Alidade and the Plane Table as used in Topographic and Geologic Surveys; Kirtley F. Mather and Bradford Washburn. 60 pp., 19 figs.
Articles 2–3, pp. 61–155, April, 1938.....$1.00
Chemistry and the Modern Meat Packing Industry; Minard Patrick. 48 pp., 3 figs.
Certain Nuclear Masses in the Macaque Medulla Oblongata—Preliminary Report; Frederick David Goudie. 47 pp., 8 figs.
Articles 4–7, pp. 157–369, December, 1938.....$1.50
The Use of Fragmentary Crinoidal Remains in Stratigraphic Paleontology; Raymond C. Moore. 86 pp., 14 figs., 4 plates.
New Ostracodes from the Golconda Formation; Carey Croneis and Arthur S. Gale, Jr. 46 pp., 2 plates.
New Ostracodes from the Kinkaid Formation; Carey Croneis and Franklin A. Thurman. 34 pp., 2 plates.
New Ostracodes from the Clore Formation, Carey Croneis and Harold J. Funkhouser. 29 pp., 2 plates.
Report of the Permanent Secretary of the DENISON SCIENTIFIC ASSOCIATION. 8 pp.

VOLUME 34

Articles 1–3, pp. 1–63, April, 1939.....$1.00
Some Factors Affecting the Operation of Incandescent Lamps; W. E. Forsythe, E. Q. Adams, and P. D. Cargill. 27 pp., 7 figs.
Taxonomy of Chester Ostracodes; Carey Croneis. 4 pp.
New Ostracodes from the Renault Formation; Carey Croneis and Ralph L. Gutke. 31 pp., 2 plates.
Articles 4–5, pp. 65–169, August, 1939.....$1.00
New Ostracodes from the Menard Formation; Carey Croneis and Hubert M. Bristol. 38 pp., 2 plates.
Pioneering in Yeneseiland. A transect across Siberia from Mongolia to the Arctic; George B. Cressey. 67 pp., 51 figs.